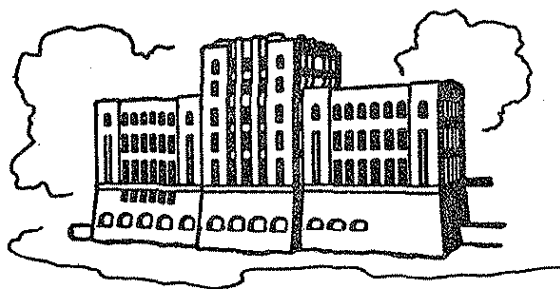


CONSTRUCTION AND EVALUATION OF SUBMERGED VANES FOR STREAM CONTROL

Research Project No. HR-274

Submitted to
The Highway Division
Iowa Department of Transportation
Ames, Iowa

by
A. Jacob Odgaard



IIHR Report No. 321
Iowa Institute of Hydraulic Research
The University of Iowa
Iowa City, Iowa 52242
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ABSTRACT

The objective of this study was to determine the practicality and effectiveness of using submerged vanes ("Iowa Vanes") to control bank erosion in a bend of East Nishnabotna River, Iowa. The vane system was constructed during the summer of 1985. It functions by eliminating, or reducing, the centrifugally induced helical motion of the flow in the bend, which is the root cause of bank undermining. The system was monitored over a 2-year period, from September 1985 to October 1987. Two surveys were conducted in the spring of 1986 in which data were taken of depths and velocities throughout the bend and of water-surface slope. The movement of the bank was determined from aerial photos and from repeated measurements of the vane-to-bank distance. The system was found to perform satisfactorily. The bankfull scour depths and velocities along the bank have been reduced significantly; and the movement of the bank has been stopped or considerably reduced. The improvements were obtained without changing the energy slope of the channel. Areas of design improvements were identified.

ACKNOWLEDGEMENTS

The Iowa Highway Research Board participated in this study. The proposal for the study was presented to the Board (on January 28, 1985) by Mark Looschen, Office of Bridge Design of the Iowa DOT. Funding was provided by the Highway Division of the Iowa Department of Transportation. The field construction was by Capital Construction Company, Logan, Iowa.

A number of individuals provided input and help during the study. Among them are: Vernon Marks, Materials Research, and Mark Looschen, Bridge Design, Iowa DOT, Ames; William G. Burgan and Tim Dunley, Resident Construction Engineers, Iowa DOT, Red Oak, and their staff; James R. Goss, Supervisor, IIHR, and his staff; and Carlos E. Mosconi, Graduate Research Assistant, IIHR. The success of the study is due to a great extent to these individuals.

The opinions, findings, and conclusions of this report are those of the author and not necessarily those of the Highway Division of the Iowa Department of Transportation.

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CONSTRUCTION AND EVALUATION OF SUBMERGED VANES FOR STREAM CONTROL

I. INTRODUCTION

Most streams have a natural tendency to meander and migrate. By eroding the outer banks of their channels, the streams gradually change their alignment. This process often interferes adversely with human activities such as those related to the infrastructure of the society.

Different techniques are available to control this process. The techniques involve either armoring of the concave banks by one means or another, ranging from protecting them with stone or concrete to enhanced vegetative cover; or reduction of the near-bank velocity by dikes or other structures that increase the local channel roughness or shelter the banks. A review of various bank-protection measures has been presented by the U.S. Army Corps of Engineers (1981) and by Jansen et al. (1979). The Corps' report shows that one of the principal obstacles to amelioration of the bank-erosion problem is the cost of these techniques.

A less costly, and environmentally more acceptable, technique has been developed recently at IIHR. The technique consists of installing small submerged vanes ("Iowa Vanes") on the streambed to modify the flow pattern in the vicinity of the banks, in particular in curved reaches of the river where most of the bank failures generally occur. Without vanes, the flow in a river curve has a spiral motion. The high-velocity surface current is driven, by centrifugal acceleration, outward (and low-velocity near-bed current inward) toward the outer bank, where it produces larger depths and velocities near the banks. The channel deepening there diminishes the toe support of the bank, and the larger velocities attack it, setting the stage for bank erosion. The vanes counter the spiral motion. They are small-aspect ratio "foils" emplaced along the outer bank, at angles of 10 to 15 degrees with the mean flow, to direct the near-bed current (and bed load) outward toward the bank. By eliminating the spiral motion, the vanes make the flow and sediment go through the channel curve as if the channel were straight, in which case there should be no more bank erosion than in an equivalent straight channel. The height of the vanes is 10 to 30 percent of the high-flow water depth. The technique has been tested in laboratory experiments.

The objective of this project was to determine the practicality and effectiveness of using Iowa Vanes to control bank erosion on Iowa streams. A bend of East Nishnabotna River was selected for testing. The location of the bend is immediately upstream from the U.S. Highway 34 crossing of the East Nishnabotna River at Red Oak, Iowa. This location was selected because it was a site where the Iowa Department of Transportation was expecting to provide rock protection for the highway within the next few years.

II. DESIGN

The vane system was designed on the basis of a procedure developed in laboratory research at IIHR under contract HR-255. The procedure was detailed in a report to the Iowa Department of Transportation (Odgaard and Lee, 1984), in which also a conceptual design was presented. The theoretical background is summarized in journal papers by Odgaard and Kennedy (1982) and Odgaard and Mosconi (1987).

Figure 1 shows the layout of the vane system and details of the final vane design. Additional details may be seen in the specifications in the attached material. Each vane consisted of three creosoted planks, 7.6 cm by 30.5 cm by 3.66 m, held together in a vertical position by two HP 8 x 36 steel bearing piles driven into the streambed (about 1.5 m into a shale layer underlying a 2 to 4 m layer of sand). The planks were fastened to the piles by straps (135 by 15 by 1 cm bent plates) and were prevented from floating by anchor plates on the flanges of the H piles.

III. PRE-CONSTRUCTION ACTIVITIES

The construction was preceded by: (1) Requests for determination of permit needs submitted December 28, 1984, by the Iowa Department of Transportation, to the U.S. Army Corps of Engineers; Iowa Department of Water, Air and Waste Management; and Iowa Conservation Commission; (2) A public information meeting at Red Oak, March 19, 1985; (3) A pre-bid conference at Ames, May 30, 1985; and (4) A pre-construction conference at Red Oak, July 8, 1985. Reference material is attached.

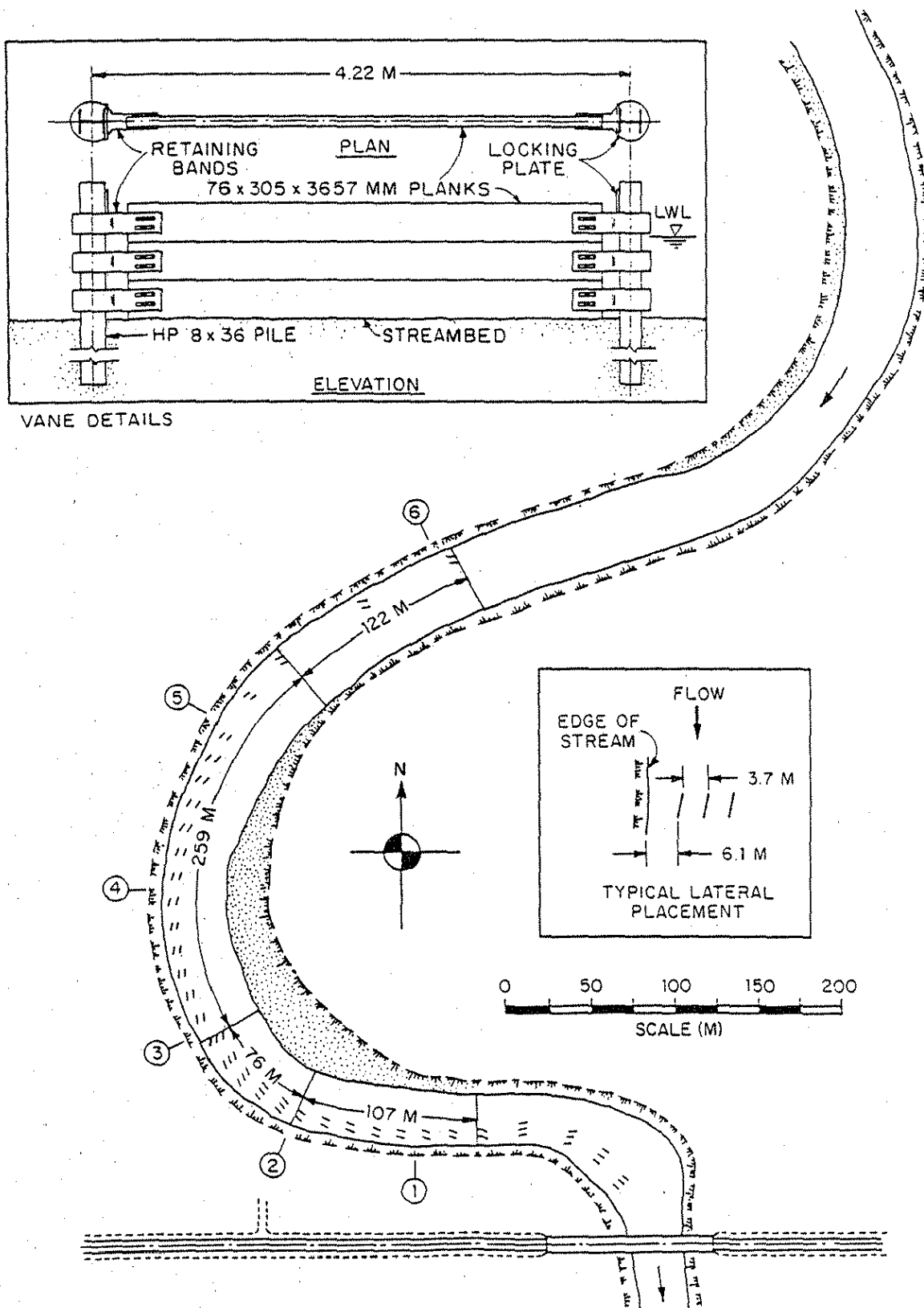


Figure 1. Layout of Vane System.

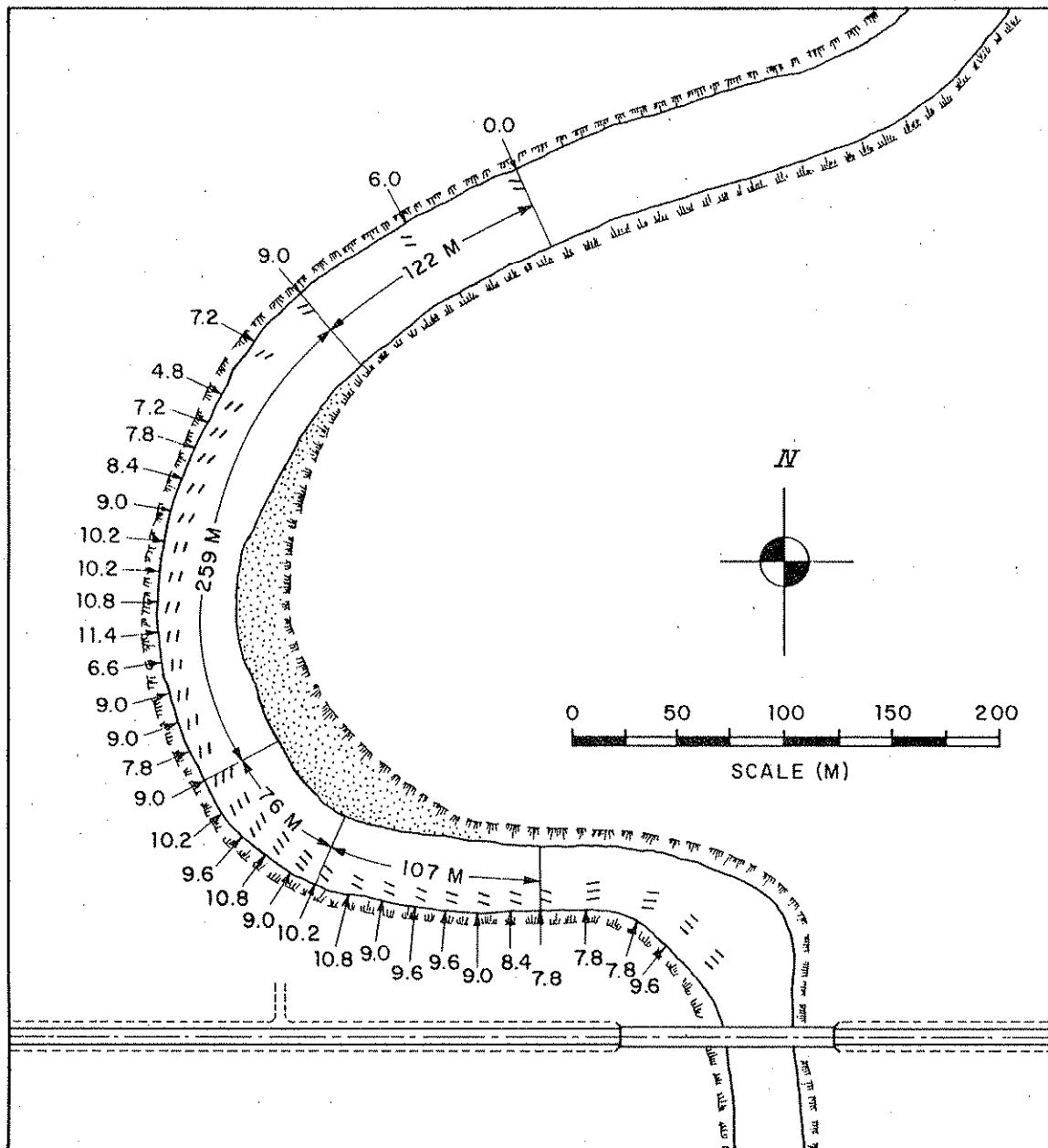


Figure 9. Vane-to-Bank Distances Measured on December 5, 1987 Aerial Photo.
Discharge = $7.5 \text{ m}^3/\text{s}$.

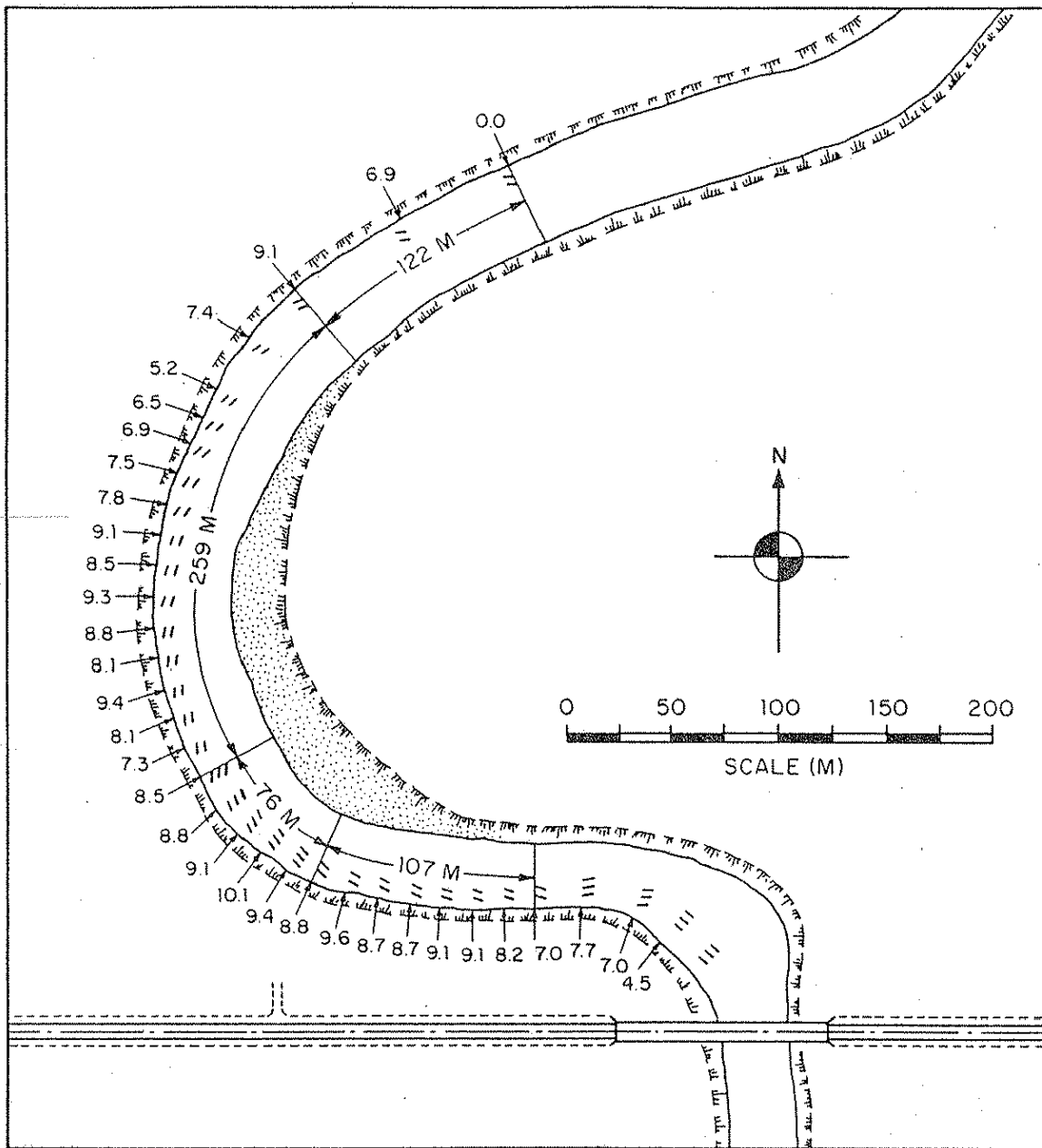


Figure 8. Vane-to-Bank Distances Measured by Iowa Department of Transportation Red Oak District Personnel on August 29, 1986. Discharge = $10.6 \text{ m}^3/\text{s}$.

was slowed due to a group of mature trees along this part of the bank. The protrusion caused an acceleration of the near-bank flow at Section 3 resulting in an undesirable increase of near-bank depth and velocity at Section 3, as seen in Figure 5. There is some concern that this may eventually lead to the forming of a channel between the bank there and the vane system. At other sections, the slope of the bank is decreasing in a favorable manner as shown schematically in Figure 7.

On August 29, 1986, personnel from the Iowa Department of Transportation Red Oak District measured the distance from the outermost upstream pile in each vane array to the edge of the water at the bank. The distance is shown in Figure 8. The average distance was about 7.9 m, or about 1.8 m larger than the design-low flow distance. The difference between the 1986 distances and the design-low flow distance is due mainly to difference in stage. On August 29, 1986, the stage was about 0.5 m higher than the stage during the installation in August of 1985. A good reference is obtained from the data along the highway, where a rock protection is maintaining a stable bankline. The August 86 average of the seven vane-to-bank distances there is 8.4 m or 0.5 m larger than the overall average August 1986 vane-to-bank distance. This suggests that overall, the low-flow vane-to-bank distance did not increase during the one year period from August 1985 to August 1986.

Vane-to-bank distances were measured again on a December 5, 1987 aerial photo. The distances are shown in Figure 9. Discharge was $7.5 \text{ m}^3/\text{s}$. The average of the seven vane-to-bank distances along the rock protection is 8.7 m, while the overall average is 8.6 m, suggesting that overall the low-flow vane-to-bank distance is still about the same as in 1985 after construction. However, along a 60 m reach around the middle of the bend, a 1-2 m increase is noted.

As expected, the bend immediately upstream from the vaned reach continues to move downstream. From September 1985 to October 1987 the outer bank in the southern corner of this bend retreated 20-30 m, as predicted based on past records. This may eventually have an adverse effect on the performance of the vane system because it is causing (1) a change in the approach angle to the uppermost vanes in the system and (2) a reduction of the radius of curvature of the bend and thus a change in the design basis. In order for the vane

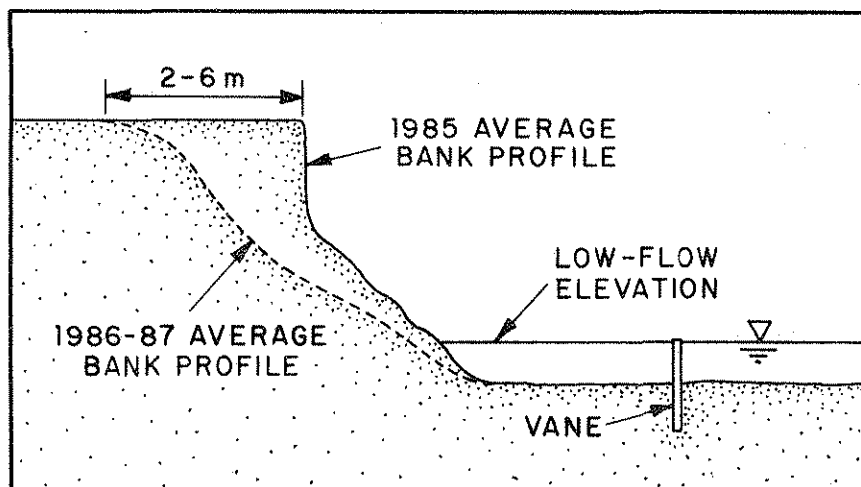


Figure 7. Schematic Comparison of Bank Profiles Before and After Installation of Vanes.

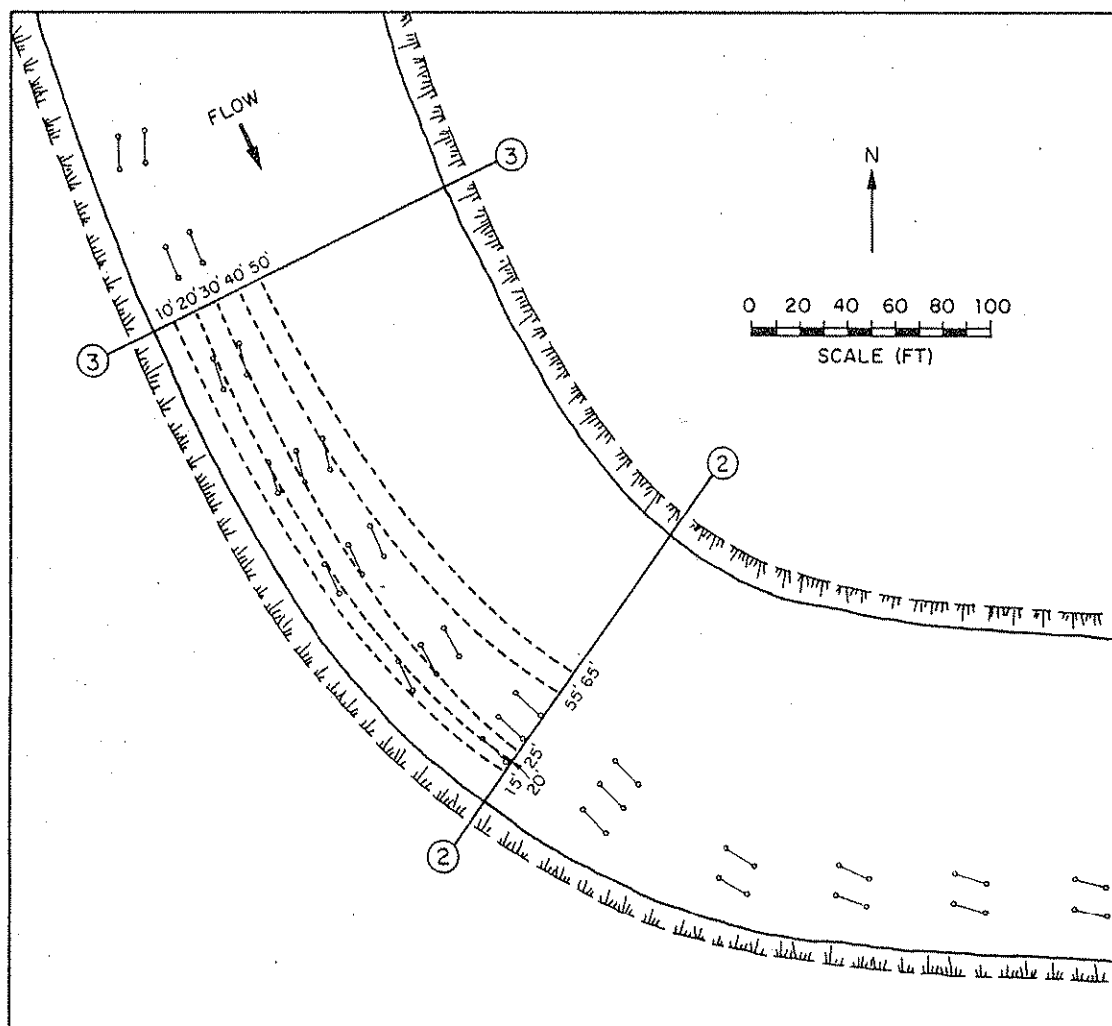


Figure 6. Average Paths of Surface Floats Measured in the May 12-13, 1986 Survey.

the transverse bed slope. The maximum velocity, which in the pre-vane cross sections generally occurred within a distance of 6 m from the bank, was moved at least 18 m away from the bank at most sections. Section 3 is an exception; the data from this section give rise to concern as explained below.

In order to directly test the vanes efficiency in eliminating the secondary-flow component, float studies were performed. Plastic balls were released at certain distances from the outer bank in Sections 3 and 4 and were followed photographically as they moved downstream through the bend. Their lateral position was recorded as they passed a downstream section. It was found that the floats generally moved away from the bank. Figure 6 shows results from the May 12-13 survey in which 500 floats were tracked between Sections 3 and 2. On the average, the floats followed the paths shown dotted in Figure 6, which indicates that the average deflection angle (toward the bank) was less than zero. In other words, there was no secondary-flow component. Without vanes, the deflection angle would have been greater than 10 degrees toward the bank.

There was no indication that the vane system changed the energy slope. The longitudinal slope of the water surface in the straight reach downstream from the bend was measured to be 0.00050, which is about the same as was measured before vanes were installed. The slope through the bend was measured to be within the range 0.00065-0.00075, which is also about the same as measured in the pre-vane situation (0.00065 - 0.00070).

No bank erosion occurred between the time of project completion and the time of the first survey. During the May 1986 high flow, the top edge of the bank receded on the average about one meter between Sections 2 and 4. Most of the erosion loss was at Section 3, where, prior to the vane installation, the bank protruded about 6 m into the channel over a length of about 30 m. These erosion losses were expected, as the pre-vane bank was too steep to be stable under undrained conditions. Because of the low percentage of sand and gravel in the bank material it may take several high flows and more erosion before the bank is cut back to a stable slope and a stable, natural toe protection is formed. The 6 m protrusion of the bank into the channel developed just prior to the vane installation when high flows caused the bank to recede about 6 m on either side of the protrusion. The erosion of the protruding bank section

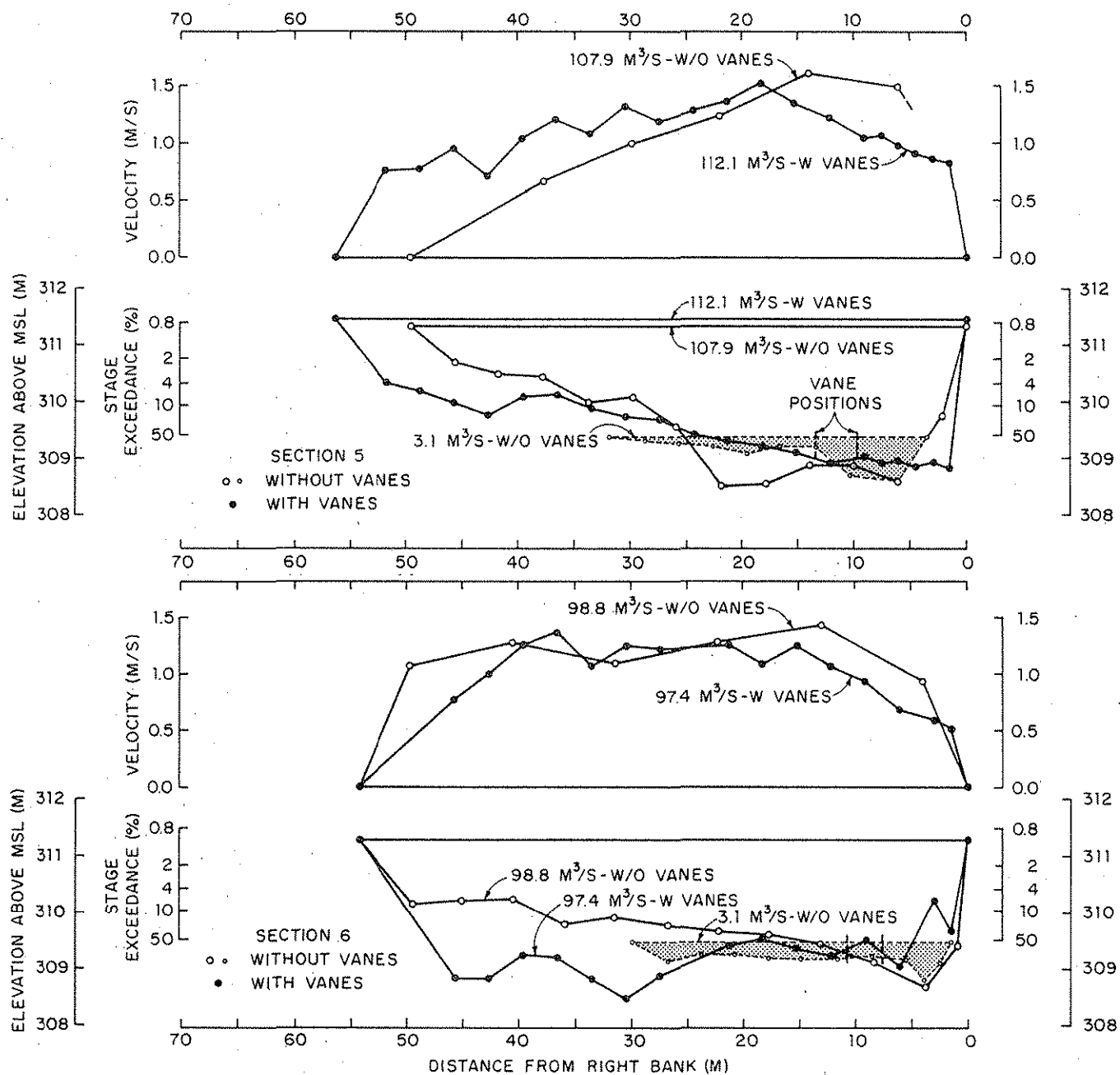


Figure 5. (Continued).

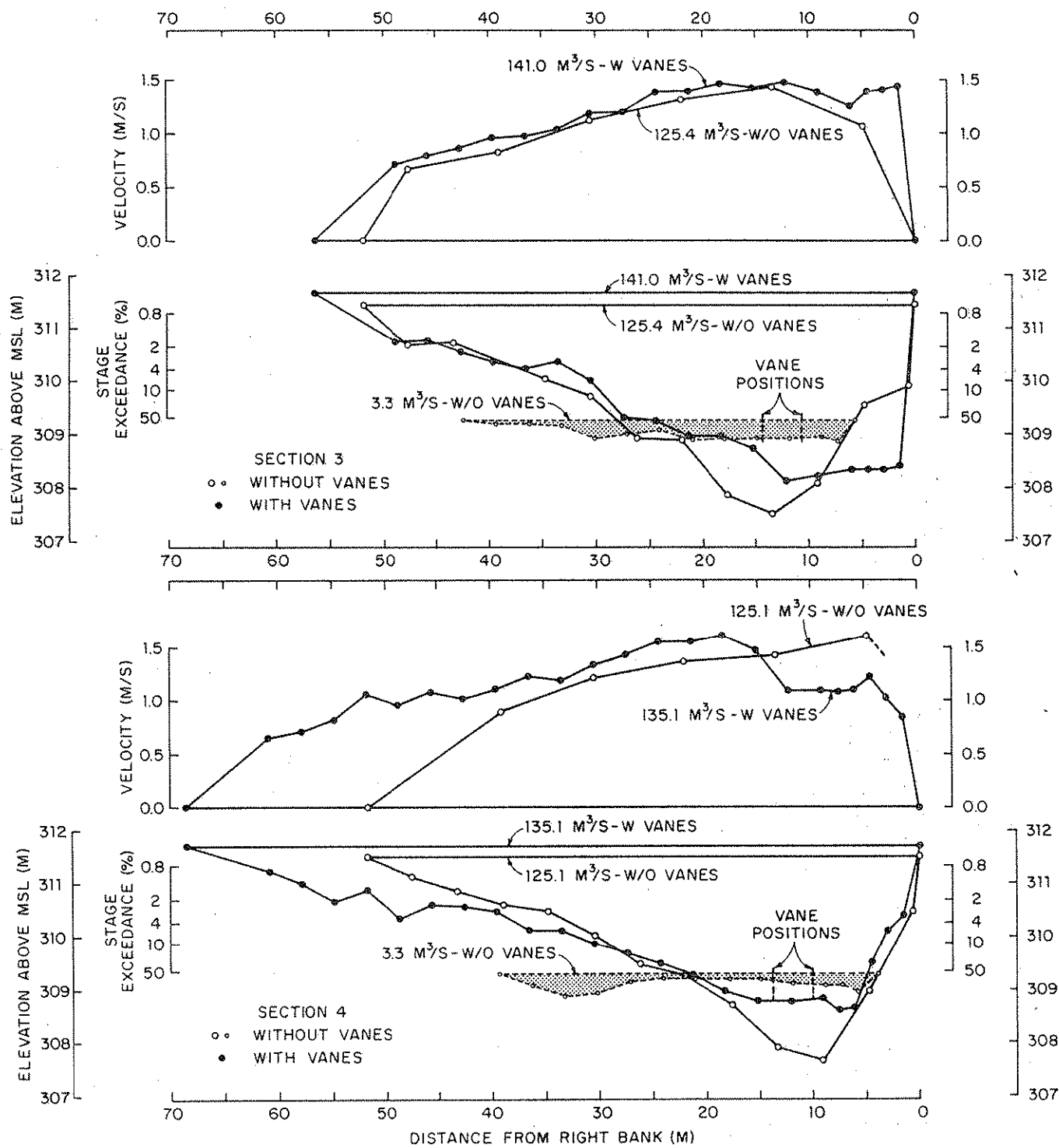


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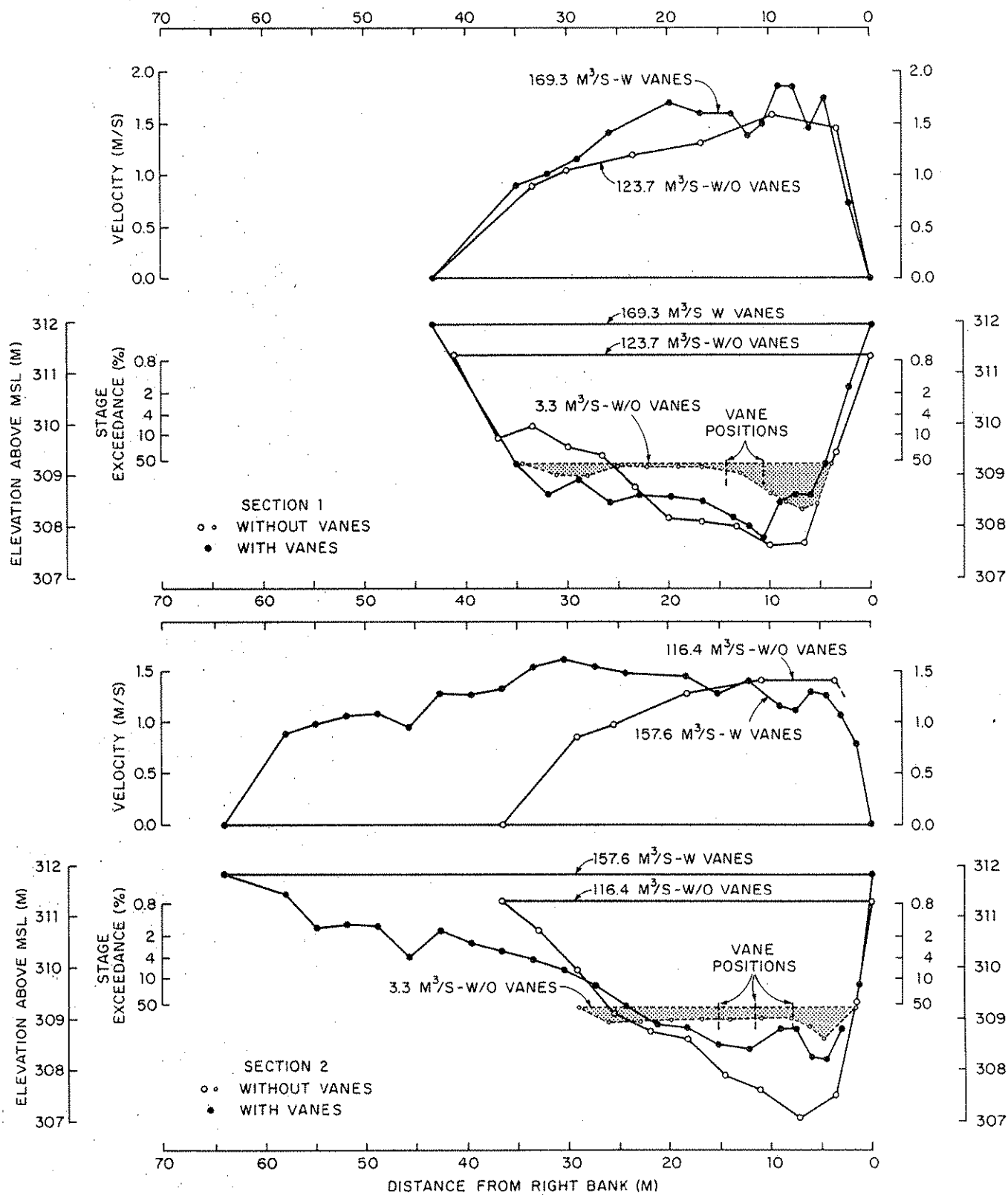


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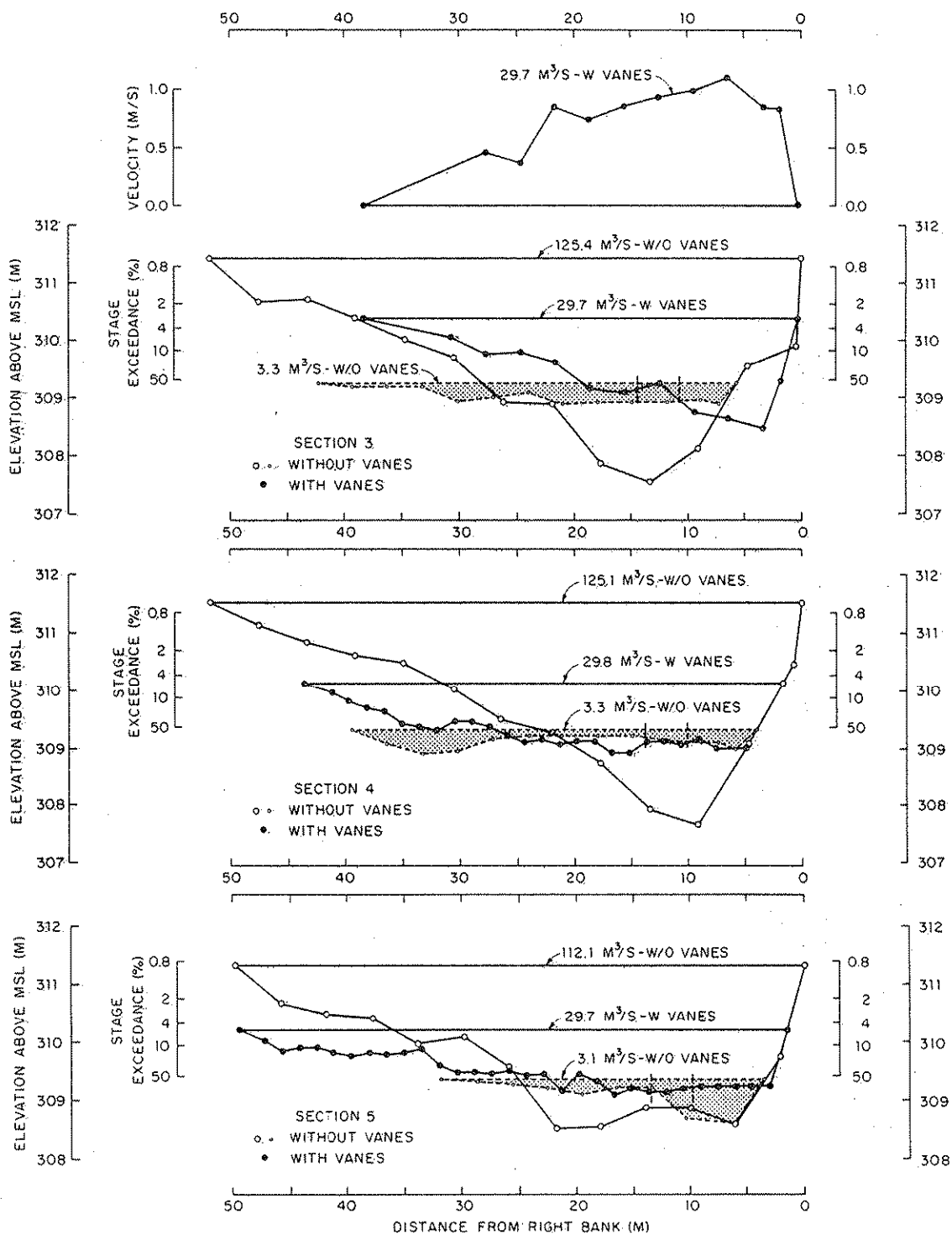


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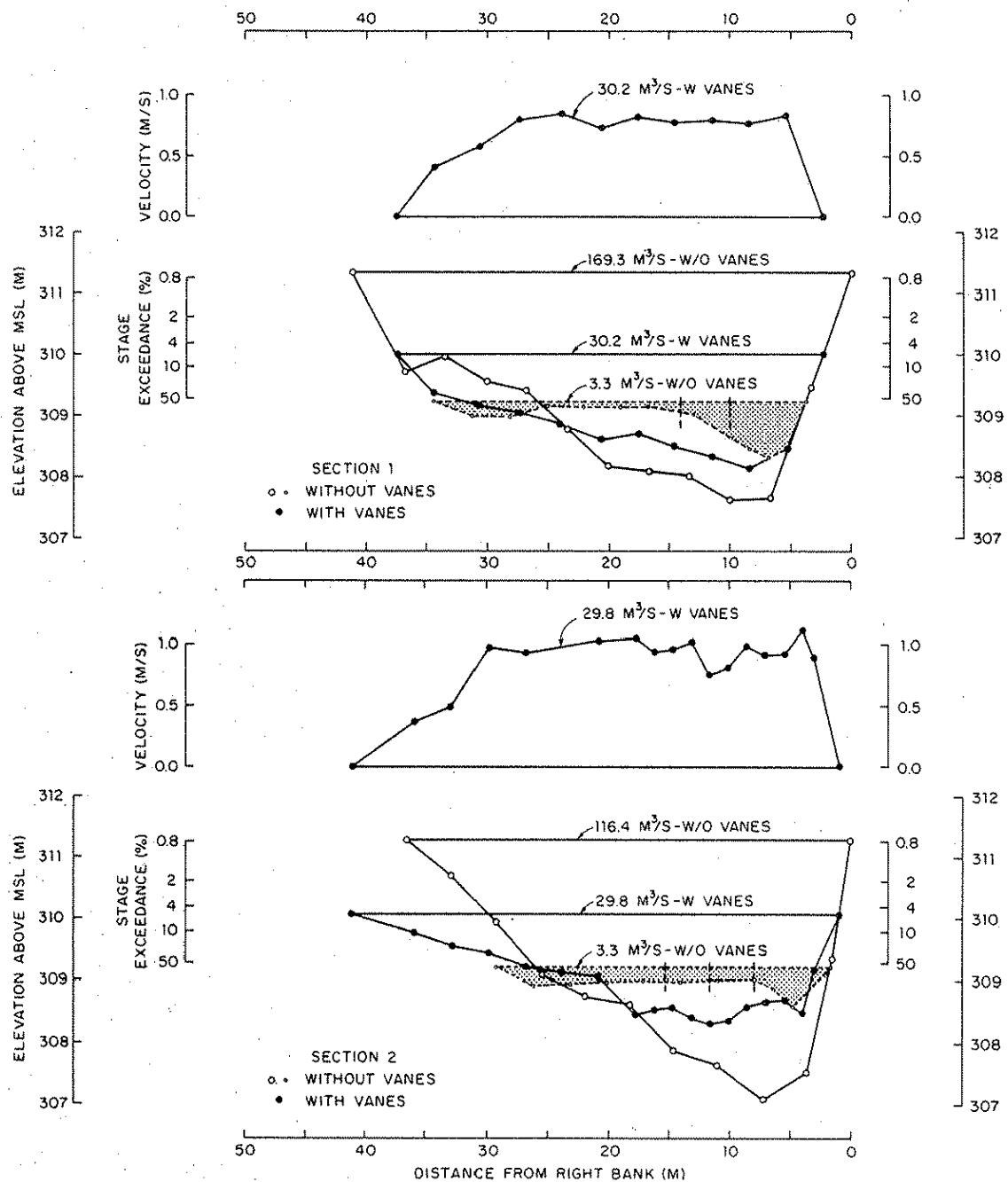


Figure 5. Sections Measured before and after Installation of Vanes.

Table 1. Summary of Section Data

Section No. (1)	Distance from bridge (m) (2)	Date of measurement (3)	Discharge (m ³ /s) (4)	Average velocity (m/s) (5)	Average depth (m) (6)	Top width (m) (7)	Vanes (8)	Transverse bed slope (9)	Elevation (m)	
									Top of vanes *) (10)	Water surface (11)
1	168	10/6/83	3.3	0.44	0.25	30	No	0.029	---	309.17
		5/1/84	123.3	1.29	2.33	41	No	0.100	---	311.37
		5/17/86	169.3	1.45	2.70	43	Yes	0.031	309.42	311.92
		3/20/86	30.2	0.73	1.16	35	Yes	0.043	309.42	309.95
2	244	10/6/83	3.3	0.46	0.27	27	No	0.009	---	309.20
		5/1/84	116.4	1.26	2.51	37	No	0.140	---	311.31
		5/17/86	157.6	1.27	1.93	64	Yes	0.062	309.47	311.80
		3/20/86	29.8	0.75	0.99	40	Yes	0.044	309.47	310.03
3	320	10/6/83	3.3	0.39	0.23	28	No	0.004	---	309.23
		5/2/84	125.1	1.19	2.03	52	No	0.110	---	311.46
		5/17/86	141.0	1.24	2.01	56	Yes	0.063	309.52	311.67
		3/21/86	29.7	0.84	0.89	38	Yes	0.052	309.52	310.06
4	411	10/6/83	3.3	0.49	0.19	22	No	0.000	---	309.30
		5/2/84	125.1	1.31	1.85	52	No	0.100	---	311.51
		5/17/86	135.1	1.09	1.82	69	Yes	0.049	309.58	311.67
		3/21/86	29.7	0.91	0.78	42	Yes	0.008	309.58	310.12
5	518	10/7/83	3.1	0.43	0.27	25	No	0.036	---	309.36
		5/2/84	107.9	1.27	1.71	49	No	0.080	---	311.37
		5/18/86	112.1	1.10	1.80	56	Yes	0.030	309.65	311.46
		3/21/86	29.7	0.92	0.67	48	Yes	0.008	309.65	310.21
6	700	10/7/83	3.1	0.39	0.28	26	No	0.004	---	309.45
		5/2/84	98.8	1.18	1.54	54	No	0.013	---	311.37
		5/18/86	97.4	1.03	1.99	54	Yes	-0.011	309.77	311.37

*) Vanes nearest section
Note: 1m = 3.281 ft

were only 5 days in which the daily-average discharge exceeded $60 \text{ m}^3/\text{s}$. From July to October of 1987, on the other hand, there were 11 days in which the daily-average discharge exceeded $60 \text{ m}^3/\text{s}$, which is very unusual for a summer.

So far there has been no damage to the system. The river was ice covered from mid December of 1985 to mid February of 1986 during which period the top of the vanes were exposed. All buoys, however, disappeared during snow melt in February and March of 1986, and had to be replaced. Loss of buoys turned out to be a continuing problem. The vanes were submerged practically all of the time from mid February, 1986, to November, 1987.

Cross sections were surveyed March 20-21 and May 12-13, 1986, when the discharge was 18 percent and 58-100 percent of bankfull discharge, respectively. Measurements were taken of stage, flow depth and velocity, surface-flow paths, bank retreat and water-surface slope. Table 1 is a summary of the primary data; for comparison the table also lists data from the pre-vane surveys (From Odgaard and Lee's 1984 report). The discharge was obtained by integration of the measured velocity distribution, and the elevation of the water surface from continuous stage readings at a bench mark by the bridge and from measurements of the longitudinal slope of the water surface.

Figure 5 shows the measured cross sections. The pre-vane cross sections are superimposed for comparison (the pre-vane low-flow cross section is shown dotted).

The vanes are seen to have produced a substantial reduction of the transverse slope of the bed. For example, at Section 2 the transverse slope of the bed with vanes was 0.062 at a near-bankfull discharge of $157.6 \text{ m}^3/\text{s}$, whereas the pre-vane transverse bed slope was more than twice as big (0.14) at a 26 percent lower discharge. Along the outer bank the vanes were generally able to maintain the bed at its low-flow elevation and prevent the near-bank scour typical of the pre-vane cross section. Instead of scouring along the outer bank, the flow at most sections widened its channel by removing sand from the inside point bar. For the same discharge there is seen to have been little difference in the average depth in the channel with and without vanes.

As seen in Figure 5, there was also a notable improvement in most of velocity distributions, which, of course, corresponds with the reduction of

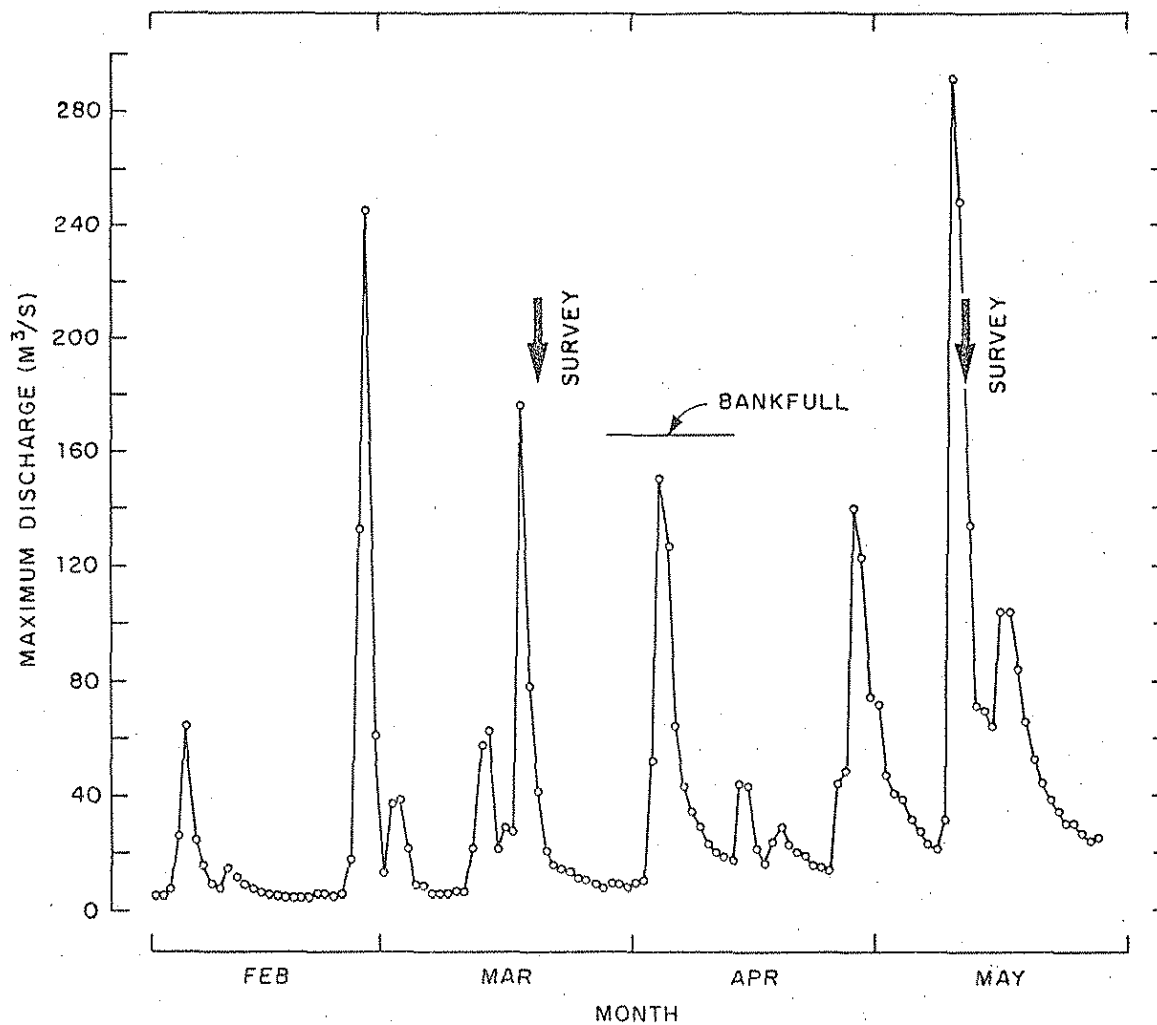


Figure 4. Spring 1986 Discharge Record for East Nishnabotna River at Red Oak.

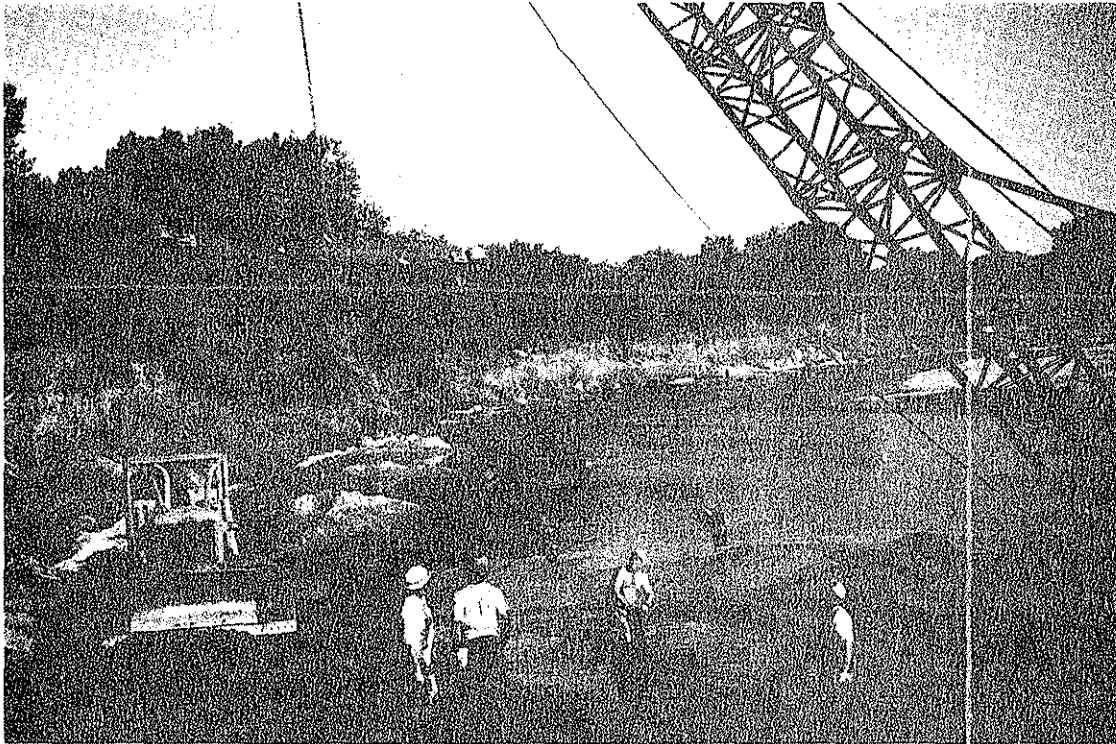


Figure 2. View from the Installation of the Vane System in the East Nishnabotna River Bend.

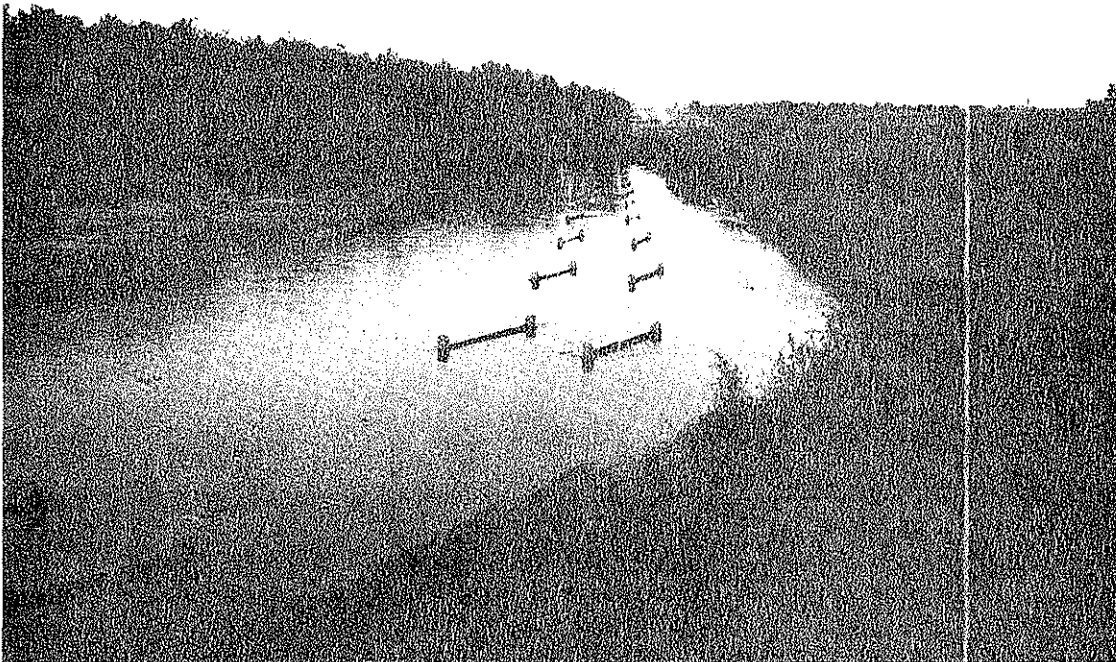


Figure 3. Downstream View of Completed System.

IV. CONSTRUCTION

The vane system was installed between July 25 and September 4, 1985. [Iowa Department of Transportation Project No. FN-34-2(27)-21-69]. The day-to-day accomplishments are summarized in the attached material. Except for two days, the water depth was less than 0.5 m throughout during this period. The construction equipment (A bulldozer, a D-15 diesel hammer, and a 25 ton American 399 crane) operated from the streambed; a 6-8 m wide berm was formed along the bank, using sand from the streambed, to facilitate the maneuvering of the equipment. The piles were driven starting at the upstream end of the bend. In each array, the upstream piles were driven at the given distances from the bank line. The downstream piles in each array were driven 4.22 m from the upstream piles and 0.9 m closer to the bank, yielding an angle with the mean-flow direction of 12.2 degrees. The direction of the mean flow was determined by floating material. In each array, the pile nearest the bank was driven about 6.1 m, or twice the bankfull flow depth, from the low-flow edge of the water. After completion of the pile driving, August 21, the planks were provided with straps and lowered in place between the piles (Figure 2). The system was provided with five can buoys (float collar cans with internal balast) and marked with the "restricted area" symbol.

The vanes between Section 1 and the bridge (Figure 1) were installed to generate a widening of the channel-cross section under the bridge and to reduce the velocity at the left abutment. These vanes were positioned to direct the bottom current away from the right bank.

Figure 3 is a downstream view of the completed system at low flow (3-4 m^3/s).

V. EVALUATION

The vane system was subjected to its first test in the spring of 1986, which was among the wettest on record. From February to June, there were 22 days in which the daily-average discharge exceeded 60 m^3/s (a record exceeded only twice since 1973). The maximum-discharge record is shown in Figure 4. The spring of 1987 was wetter than the spring of 1986 in terms of water volume. However, there were fewer extreme events. From February to June there

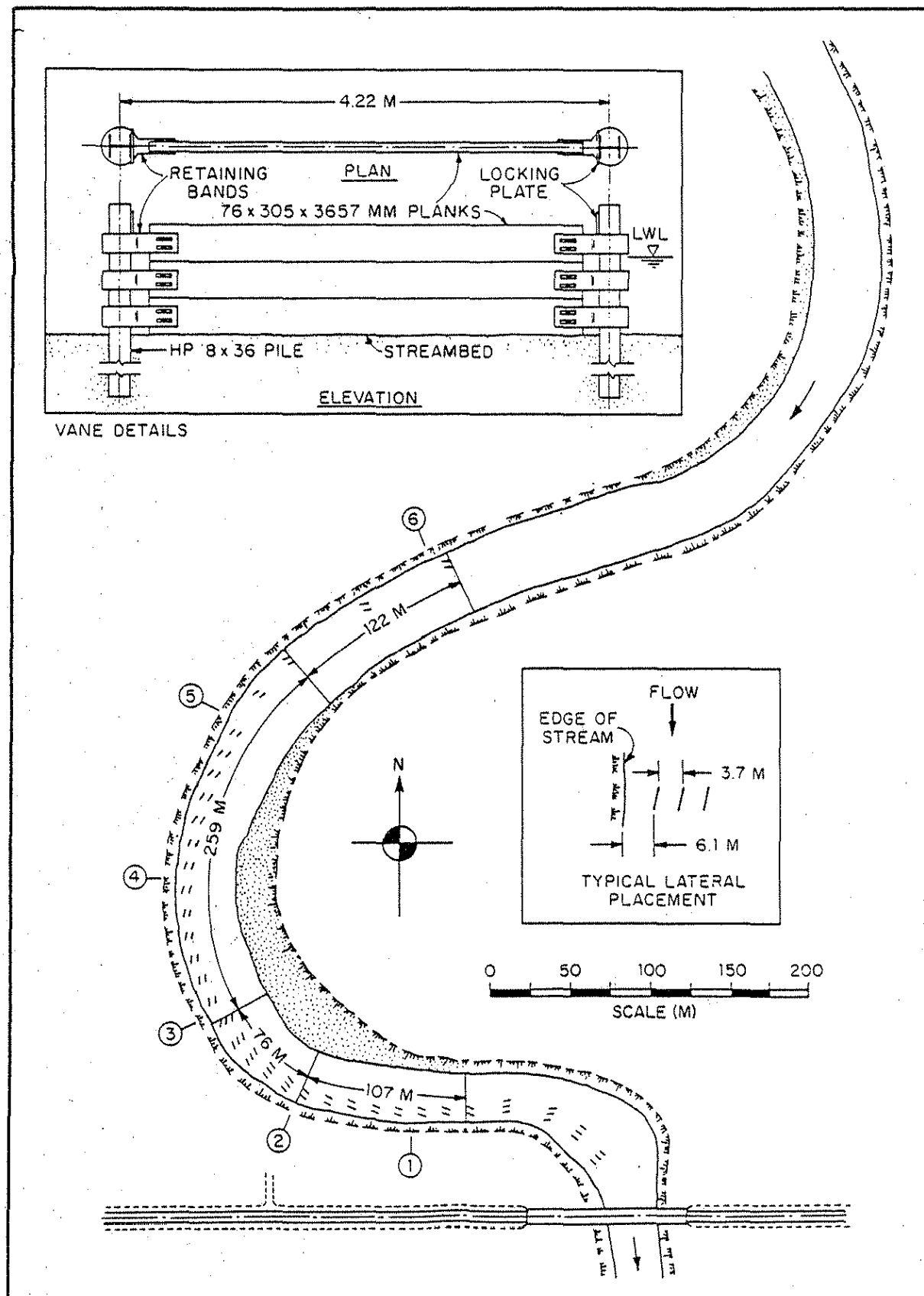


Figure 1. Layout of Vane System.

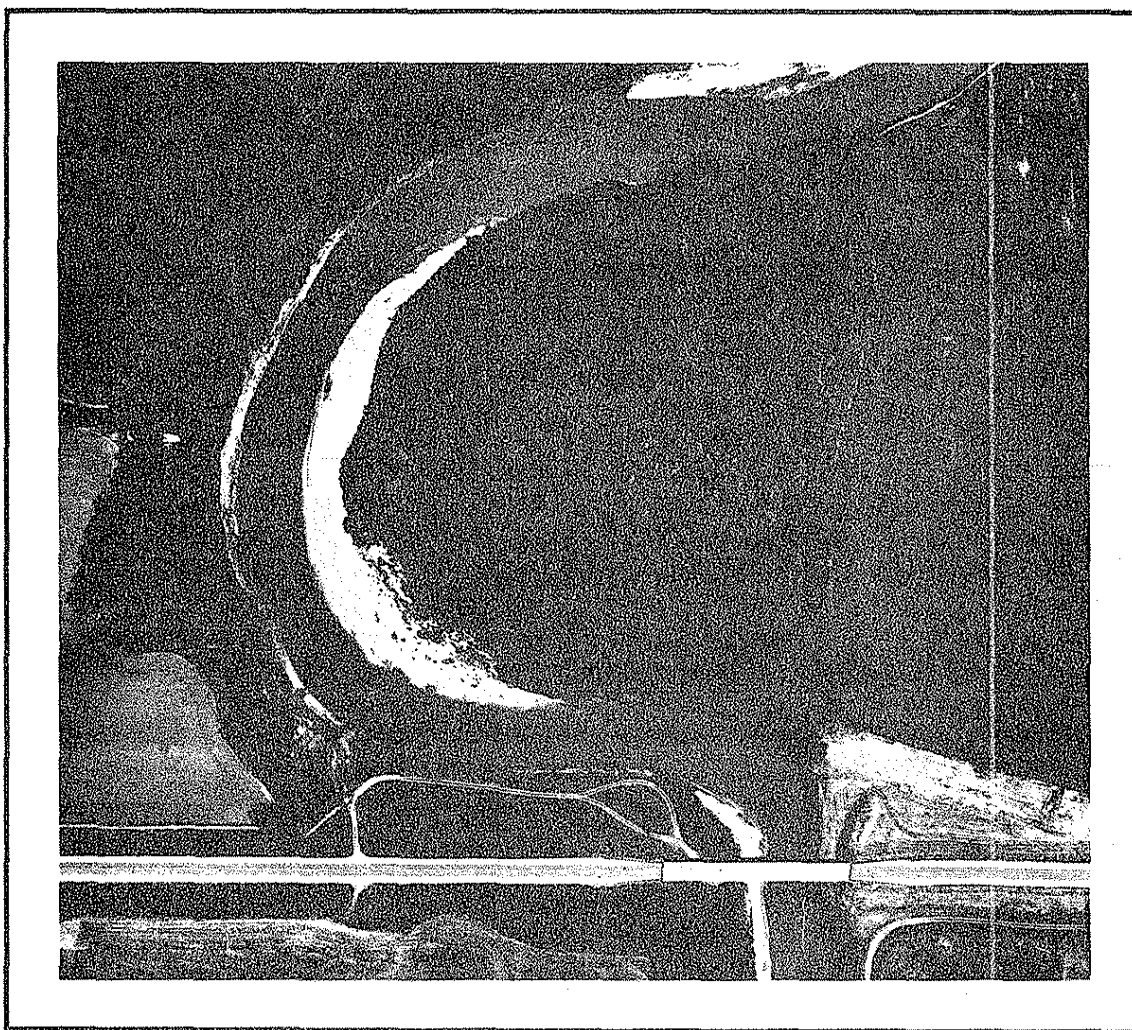


Figure 10. Aerial Photo of Bend on June 20, 1985 (Immediately before Construction) Discharge = $5.5\text{m}^3/\text{s}$.

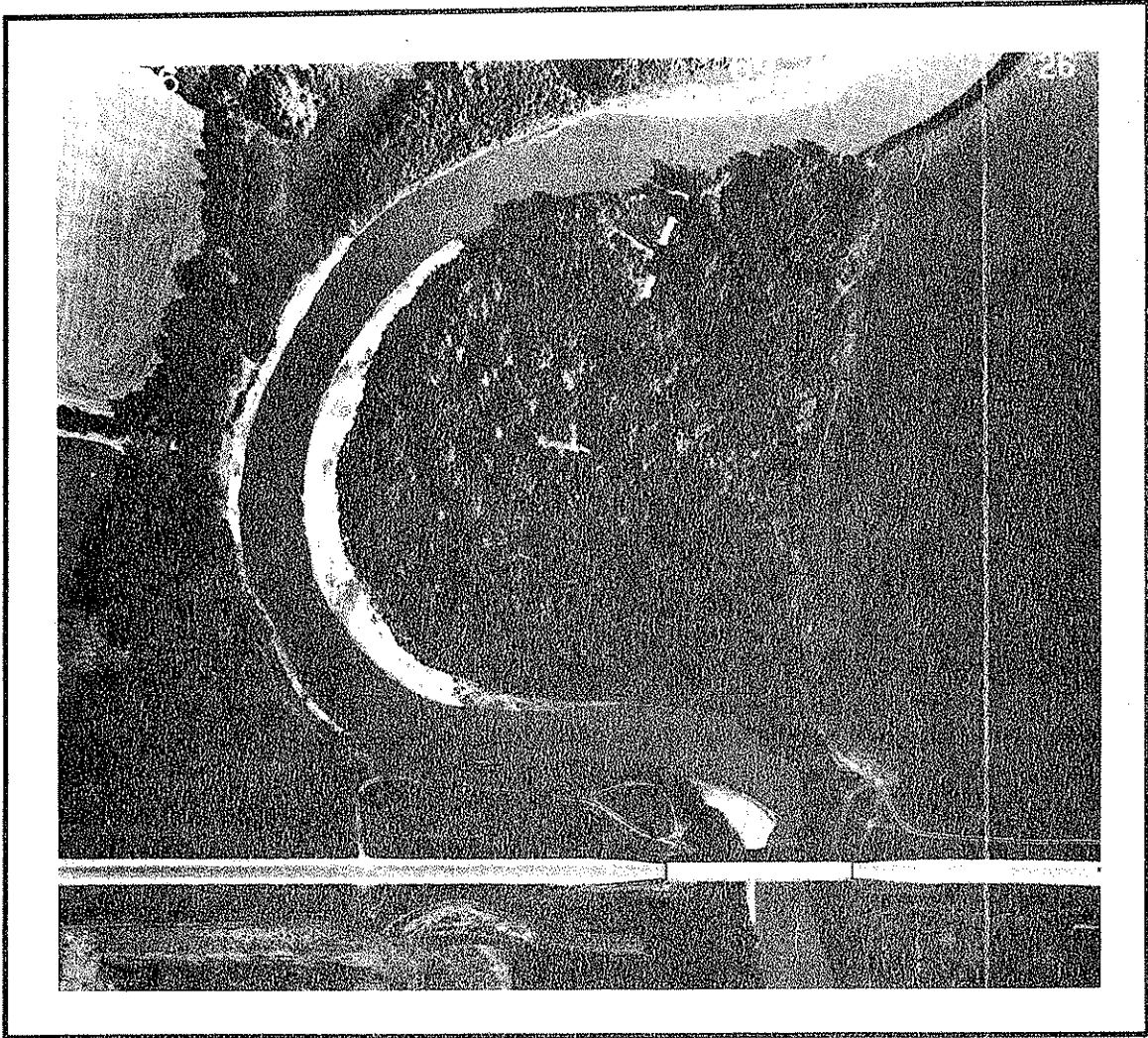


Figure 11. Aerial Photo of Bend on September 8, 1986.
Discharge = $10.2\text{m}^3/\text{s}$.

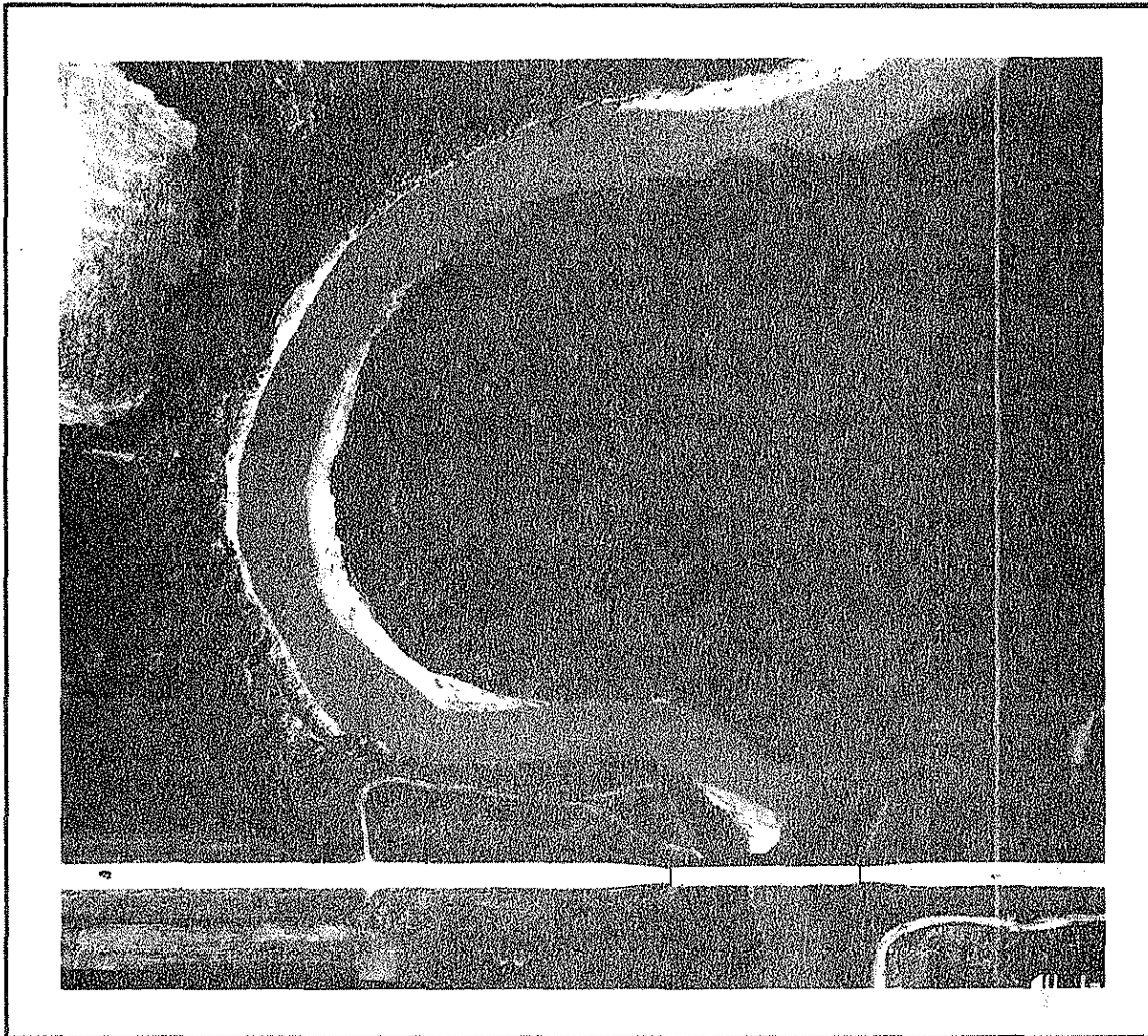


Figure 12. Aerial Photo of Bend on August 11, 1987.
Discharge = $13.6 \text{ m}^3/\text{s}$.

It is further recommended that a new vane design be adopted for the aforementioned additional vanes, as well as for future installations. In recent laboratory studies at IIHR a design has been developed which is significantly more efficient than the design used (Figure 1). The new vane is a streamlined, three-dimensional structure with a double-curved surface mounted on a pile in such a way that the part of the pile which is above the streambed is surrounded and covered by the surface of the vane. The new structure has no sharp edges or corners and presents a lesser hazard to recreational activities on the river than does the design used. The new vane may be placed closer to the bank and possibly with a lower top elevation than the present vanes in the river.

VII. CONCLUSIONS

So far, the data indicate that the vane concept is an effective flow control device and a realistic alternative to presently used techniques for streambank protection. The design in the East Nishnabotna River bend produced a reduction of the high-flow transverse bed slope of at least 50 percent and a reduction of the near-bank velocity of, generally, 10 to 20 percent moving the velocity maximum toward the center of the channel. During the period from September 1985 to October 1987, the channel alignment did not change measurably, despite several record floods through the channel. Overall, the top edge of the bank retreated on the average about 2 m, with a maximum of about 6 m near apex of the bend. The toe of the bank showed no substantial movement along most of the bank. Over a 60-m long reach around apex, a 1-2 m retreat of the toe was noted. Based on past records, the floods of this period would have produced a bank retreat of at least 20 m if vanes had not been installed. (The outer bank of the bend immediately upstream from the vaned bend retreated 20-30 m during the same period). The system did not cause any measurable change in the longitudinal slope of the water surface, nor in the average depth for a given discharge. Most alternative bank protection techniques produce significant changes of both slope and average depth.

However, the study has identified features with the technique which need to be modified. The design for the East Nishnabotna bend was based on only partial elimination of the secondary-flow component. The data show that the

system should have been designed to provide for a complete elimination of that component to provide more favorable conditions for the forming of a natural toe protection along the bank and to make the system less sensitive to any unevenness in the pre-vane bank line. A complete account of the new design procedure is presented in the journal paper by Odgaard and Mosconi (1987).

Because of the sensitivity of vane performance to the approach-flow angle, more vanes should have been installed at the crossover between this and the upstream bend to maintain the correct approach angle to the uppermost vanes in the system, or, better yet, the upstream bend should have been stabilized. The latter would have been a realistic solution because the upstream bend is preceded by a long, nearly straight reach.

The greatest drawback of the technique at this site is that the vanes are exposed a large portion of the year. About 50 percent of the time the flow in the river is equal to or less than $4 \text{ m}^3/\text{s}$. Their exposure, or near exposure, makes them a hazard to users of the river, primarily snowmobiles, ice boats and watercraft.

The cost (1984) of the East Nishnabotna installation was \$174 per meter of bank (\$53 per foot). For comparison, the 1984-cost of a rock riprap structure along a comparable reach of the nearby Racoon River by Highway 90 [Iowa Department of Transportation Project No. FN-90-1(6)-21-25] was \$341 per meter of bank (\$104 per foot), or about twice that of the East Nishnabotna installation.

The vane/rock-riprap cost ratio of future bank protection projects is likely to be considerably less than that of the East Nishnabotna project if the aforementioned new vane design is adopted. By the new design, the same degree of protection can be achieved by less than half the number of vanes required with the Fig. 1 design. Moreover, the new design utilizes only one pile per vane, and its top elevation is lower than that of the present design.

REFERENCES

- Jansen, P. Ph., Bendegom, L. van, Berg, J. van den, Vries, M. De, and Zanen, A., eds. (1979). Principles of River Engineering, Pitman Publishing Ltd., London.
- Odgaard, A.J. and Lee, H.Y. (1984). "Submerged Vanes for Flow Control and Bank Protection in Streams," IIHR Report No. 279, Iowa Institute of Hydraulic Research, The University of Iowa, Iowa City, Iowa.
- Odgaard, A.J. and Kennedy, J.F. (1983). "River-Bend Bank Protection by Submerged Vanes", Journal of Hydraulic Engineering, ASCE, 109(8), 1161-1173.
- Odgaard, A.J. and Mosconi, C.E. (1987). "Streambank Protection by Submerged Vanes", Journal of Hydraulic Engineering, ASCE, 113(4), 520-535.
- U.S. Army Corps of Engineers (1981). The Streambank Erosion Control Evaluation and Demonstration Act of 1974 Section 32, Public Law 93-251, Final Report to Congress (Published at the Waterways Experiment Station, Vicksburg, Mississippi).

ATTACHMENTS

MONTGOMERY COUNTY STRUCTURES (VANES)
FN-34-2(27)--21-69

<p>CONVENTIONAL SIGNS</p> <p>State Line Co. Line Twp. Line Sec. Line City Line Village Line R.O. Line Survey Line</p> <p>Int. Center Public Center Road Rail Underpass Culvert Underpass Ramp Front On Road Street Side</p> <p>County Road No. Primary Road No. U.S. Road No. Intersecting Road No.</p>	<p>IOWA DEPARTMENT OF TRANSPORTATION Highway Division PLANS OF PROPOSED IMPROVEMENT ON THE PRIMARY ROAD SYSTEM MONTGOMERY COUNTY VANES EAST NISHNABOTNA RIVER JUST WEST OF RED OAK SCALE: 1" = 100'</p> <p>THE STANDARD SPECIFICATIONS SERIES OF 1984 OF THE IOWA DEPARTMENT OF TRANSPORTATION SHALL APPLY TO CONSTRUCTION WORK ON THIS PROJECT PLUS CURRENT SUPPLEMENTAL SPECIFICATIONS AND SPECIAL PROVISIONS</p>	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th>NO.</th> <th>DESCRIPTION</th> </tr> <tr> <td>1</td> <td>TITLE SHEET</td> </tr> <tr> <td>2</td> <td>ESTIMATE SHEET</td> </tr> <tr> <td>3-13</td> <td>DESIGN NO. 284</td> </tr> </table>	NO.	DESCRIPTION	1	TITLE SHEET	2	ESTIMATE SHEET	3-13	DESIGN NO. 284	<div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p>LOCATION MAP</p> <p>LOCATION MAP SCALE</p> <p>0 1 2 3 miles</p> </div> <div style="width: 45%;"> <p>DESIGN NO. 284</p> <p>R-38W</p> <p>RED OAK</p> </div> </div>
NO.	DESCRIPTION										
1	TITLE SHEET										
2	ESTIMATE SHEET										
3-13	DESIGN NO. 284										

LETTING DATE JUNE 11, 1985

STATE CONTROL SECTION NUMBER 69-0400

FILE NO. 27119

MONTGOMERY COUNTY

PROJECT NO. FN-34-2(27)--21-69 SHEET NO. 1 OF 13

I HEREBY CERTIFY THAT THE ABOVE QUANTITIES WERE PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A duly licensed professional engineer in the State of Montana. I am not a resident of Montana.

6/1/75 *James H. Smith* AID NO. 6148

I HEREBY CERTIFY THAT THE ABOVE QUANTITIES WERE PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A duly licensed professional engineer in the State of Montana. I am not a resident of Montana.

6/1/75 *James H. Smith* AID NO. 6148

SECTION 32

DESIGN FOR
SUBGRADE VAND FOR FLOW
CONTROL AND BASE PROTECTION

SECTION 32

ESTIMATE OF QUANTITIES

NO.	ITEM	UNIT	TOTAL
1	STRUCTURAL STEEL	LB.	17,440
2	PER A.E. IN STEEL	SQ. FT.	1.00
3	BRACING PLATE	SQ. FT.	1.00
4	CRUSHED LIMESTONE	CY	1.00
5	ASPHALT	SQ. YD.	1.00
6	GRAVEL	CY	1.00

ESTIMATE REFERENCE INFORMATION

ITEM NO. 1 DESCRIPTION 1

2

3

4

5

6

ESTIMATED ROADWAY QUANTITIES

NO.	ITEM	UNIT	TOTAL
1	ITEM 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100		

ESTIMATE REFERENCE INFORMATION

ITEM NO. 1 DESCRIPTION 1

2

3

4

5

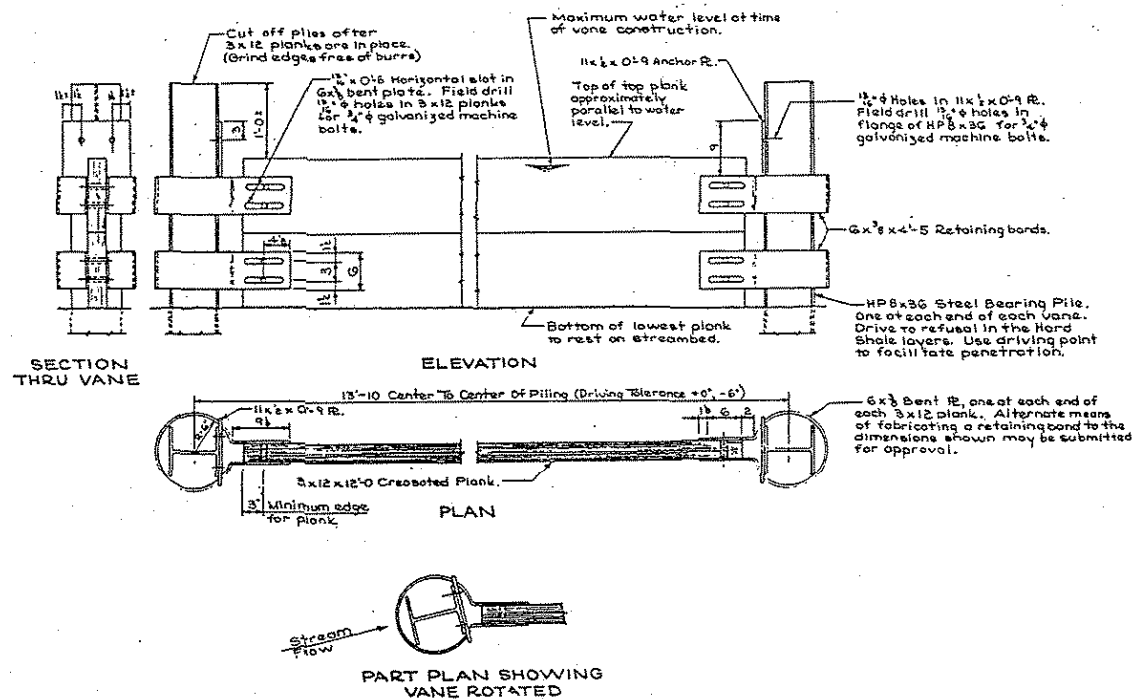
6

FILE NO. 27119

MONTGOMERY COUNTY

FN-34-21271-21-69

ESTIMATE SHEET



- PART INSTALLATION SEQUENCE
1. DRIVE UPSTREAM STEEL PILE TO AT LEAST 6" PENETRATION INTO HARD SHALE.
 2. PLACE 1-3x12 PLANK WITH THE STEEL RETAINING BAND AROUND THE UPSTREAM PILE. ALIGN THE PLANK WITH THE STREAM FLOW.
 3. MOVE THE DOWNSTREAM END OF THE PLANK TWO TO THREE FEET TOWARDS OR AWAY FROM THE BANK.
(THE FIRST FOUR SETS OF 3 BARS AT LOCATIONS 1, 2, 3 & 4 SHALL BE MOVED TWO TO THREE FEET AWAY FROM THE BANK, THE REMAINING SETS OF BARS AT LOCATIONS 5 THRU 24 SHALL BE MOVED TWO TO THREE FEET TOWARDS THE BANK.)
 4. DRIVE THE DOWNSTREAM STEEL PILE AT THE LOCATION OF THE OPEN STEEL RETAINING BAND ATTACHED TO THE 2x12 PLANK SO AS TO MAINTAIN THE PLANK IN ITS SHIFTED POSITION. THE STEEL PILE SHALL BE DRIVEN TO AT LEAST 6" PENETRATION.
 5. INSTALL ADDITIONAL 2x12 PLANKS WITH STEEL RETAINING BANDS AS NEARLY TO SEAT THE BOTTOM PLANK ON NATURAL STREAM BED.
 6. INSTALL ANCHOR PLATES ABOVE THE TOP PLANK AT BOTH PILES.
 7. CLEAN AND PAINT THE EXPOSED UPPER 1/2" OF THE STEEL PILE AND ANCHOR PLATES.

NOTE:
This table is for estimating purposes only. The number of planks per vane will be determined by the Engineer at the time of construction. The contractor will be paid for the actual number of planks installed plus 20 additional planks. Article 1109.03 of the Standard Specifications shall not apply.

VANE INFORMATION											
Location Number	Number Of Vane	Number Of Planks Per Vane	Location Number	Number Of Vane	Number Of Planks Per Vane	Location Number	Number Of Vane	Number Of Planks Per Vane	Location Number	Number Of Vane	Number Of Planks Per Vane
1	3	2	10	2	3	19	2	2	28	2	4
2	3	2	11	2	3	20	2	2	29	2	4
3	3	2	12	2	3	21	2	3	30	2	4
4	3	2	13	3	2	22	2	3	31	2	3
5	2	3	14	3	2	23	2	3	32	2	3
6	2	3	15	3	2	24	2	3	33	2	3
7	2	4	16	3	2	25	2	3	34	2	4
8	2	3	17	3	2	26	2	4			
9	2	3	18	2	2	27	2	4			

Design For
SUBMERGED VANES FOR FLOW
CONTROL AND BANK PROTECTION

TYPICAL VANE DETAILS
Station: 417+00.00, Lt. 265'± April 1985
MONTGOMERY COUNTY
IOWA DEPARTMENT OF TRANSPORTATION-HIGHWAY DIVISION
Design Sheet No. 2 Of 11 Rte No. 2719 Design No. 284

MONTGOMERY EBBTJ

PROJECT SHEET

DATE: 4/1/85 BY: EBBTJ CHECK: JCS DATE: 4/1/85

STICKING NOTES

INSTALL AND OPERATING ONLY. REFER TO THE REQUIREMENTS OF THE APPLICABLE SECTION OF THE ROAD DEPARTMENT'S TRANSPORTATION STANDARD SPECIFICATIONS FOR HIGHWAY AND BRIDGE CONSTRUCTION, SERIES OF 1944.

THE EXACT LOCATION FOR AND TYPE TO BE INSTALLED IS SUBJECT TO APPROVAL BY THE ENGINEER.

THE FOLLOWING TOLERANCES WILL BE ALLOWED ON ALL SIGNS, ACCUMULATIVE ERROR OF NOT GREATER THAN 0.007 FOR LINE OF COPY, NOT GREATER THAN 0.007 FOR SPACING BETWEEN LINES OF COPY AND SPACING BETWEEN LINES OF COPY AND THE INNER EDGE OF THE LINE NUMBER.

THE FOLLOWING TOLERANCES WILL BE ALLOWED ON EACH LETTER OR SYMBOL. THE REQUIREMENTS WILL BE MADE TO THE NEAREST 1/16".		
MINIMUM HEIGHT	VARIATION IN HEIGHT	VARIATION IN WIDTH
1" TO 2"	-1/16" TO +1/16"	-1/16" TO +1/16"
OVER 2"	-1/16" TO +1/16"	-1/16" TO +1/16"

ESTIMATE OF QUANTITIES (ITEMS)		
ITEM	UNIT	QUANTITY
TYPE 1, 4" OR 6" WOOD POSTS		
4" x 6"	LIN. FT.	60
6" x 6"	LIN. FT.	10
OVERHEAD SIGN BRACKET ASSEMBLY		
TYPE 11 (AL. OR STEEL)		
2 BRACKET	EA.	1

SUMMARY OF SIGNING MATERIALS				
SIGN NO.	LOCATION	WOOD SIGN TYPE	WOOD POST ASSEMBLY	OVERHEAD SIGN BRACKET ASSEMBLY
		HEIGHT (FT.)	WEIGHT (LBS.)	QUANTITY
10-40-1	ON BRIDGE	4.5	32.5	-
10-40-2	1/2 MI. NORTH OF BRIDGE	4.5	32.5	2
10-40-3	1/2 MI. NORTH OF BRIDGE	4.5	32.5	2
TOTALS			57.5	40

SIGNING DESIGN

DESIGN NO. 2-5-4

FILE NO. 2-7114

DES. 3, 31, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100

STICKING NOTES, ESTIMATE OF QUANTITIES (12/18/16)

AND SUMMARY OF SIGNING MATERIALS.

MONITORING/DESIGN

DES. 3, 31, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100

SR-65-1,243

$\text{Mg}(\text{ClO}_4)_2$	3.5%	9.50%
LiClO_4	4.1%	1.10%
MgCl_2	22.9%	2.0%

C 14	C 15	C 16	C 17	C 18	C 19	C 20	C 21	C 22	C 23	C 24	C 25	C 26	C 27	C 28	C 29	C 30	C 31	C 32	C 33	C 34	C 35	C 36	C 37	C 38	C 39	C 40	C 41	C 42	C 43	C 44	C 45	C 46	C 47	C 48	C 49	C 50	C 51	C 52	C 53	C 54	C 55	C 56	C 57	C 58	C 59	C 60	C 61	C 62	C 63	C 64	C 65	C 66	C 67	C 68	C 69	C 70	C 71	C 72	C 73	C 74	C 75	C 76	C 77	C 78	C 79	C 80	C 81	C 82	C 83	C 84	C 85	C 86	C 87	C 88	C 89	C 90	C 91	C 92	C 93	C 94	C 95	C 96	C 97	C 98	C 99	C 100	C 101	C 102	C 103	C 104	C 105	C 106	C 107	C 108	C 109	C 110	C 111	C 112	C 113	C 114	C 115	C 116	C 117	C 118	C 119	C 120	C 121	C 122	C 123	C 124	C 125	C 126	C 127	C 128	C 129	C 130	C 131	C 132	C 133	C 134	C 135	C 136	C 137	C 138	C 139	C 140	C 141	C 142	C 143	C 144	C 145	C 146	C 147	C 148	C 149	C 150	C 151	C 152	C 153	C 154	C 155	C 156	C 157	C 158	C 159	C 160	C 161	C 162	C 163	C 164	C 165	C 166	C 167	C 168	C 169	C 170	C 171	C 172	C 173	C 174	C 175	C 176	C 177	C 178	C 179	C 180	C 181	C 182	C 183	C 184	C 185	C 186	C 187	C 188	C 189	C 190	C 191	C 192	C 193	C 194	C 195	C 196	C 197	C 198	C 199	C 200	C 201	C 202	C 203	C 204	C 205	C 206	C 207	C 208	C 209	C 210	C 211	C 212	C 213	C 214	C 215	C 216	C 217	C 218	C 219	C 220	C 221	C 222	C 223	C 224	C 225	C 226	C 227	C 228	C 229	C 230	C 231	C 232	C 233	C 234	C 235	C 236	C 237	C 238	C 239	C 240	C 241	C 242	C 243	C 244	C 245	C 246	C 247	C 248	C 249	C 250	C 251	C 252	C 253	C 254	C 255	C 256	C 257	C 258	C 259	C 260	C 261	C 262	C 263	C 264	C 265	C 266	C 267	C 268	C 269	C 270	C 271	C 272	C 273	C 274	C 275	C 276	C 277	C 278	C 279	C 280	C 281	C 282	C 283	C 284	C 285	C 286	C 287	C 288	C 289	C 290	C 291	C 292	C 293	C 294	C 295	C 296	C 297	C 298	C 299	C 300	C 301	C 302	C 303	C 304	C 305	C 306	C 307	C 308	C 309	C 310	C 311
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THE FOLLOWING SPECIFICATIONS SHALL APPLY TO THE SIGN STALS ON THIS SHEET AND SHALL SUPERSEDE SECTION 232.02 OF THE "STANDARD SPECIFICATIONS FOR HIGHWAY AND BRIDGE CONSTRUCTION".

HEXED: ATTENS AND MURKALS SHALL CONFORM WITH SPECIFICATIONS FOR MODIFIED SERIES 'E' FOUND IN THE "STANDARD ALPHABETS FOR HIGHWAY SIGNS", PRINTED IN 1977 BY THE U.S. DEPARTMENT OF TRANSPORTATION, FEDERAL HIGHWAY ADMINISTRATION.

INTERLINE SPEAKER: SPEAKING BETWEEN LETTERS ON HIGHWAYS SHALL CORRESPOND WITH THE SPECIFICATIONS FOUND IN "STANDARD HIGHWAY SIGNS" PRINTED IN 1925 BY THE U. S. DEPARTMENT OF TRANSPORTATION, FEDERAL HIGHWAY ADMINISTRATION.

INTELLIGENCE, U.S. ROUTE SCHEDULES, DETAILS AND DIMENSIONS INTERSTATE AND US ROUTE SCHEDULES SHALL CONFORM TO SPECIFICATIONS FOUND IN "STANDARD HIGHWAY SIGNS" PRINTED IN 1979 BY THE U.S. DEPARTMENT OF TRANSPORTATION, FEDERAL HIGHWAY ADMINISTRATION.

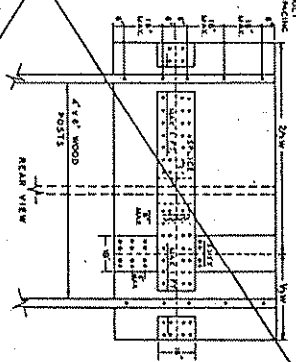
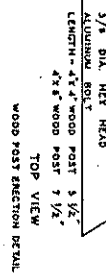
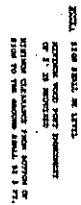
COLON: (UNLESS OTHERWISE SPECIFIED) LETTERS & NUMBERS - SMOOTH SIDER
RECTIVE SHEETING, BAC KROUND - GREEN RECTIVE SHEETING.

FOR
THE 'S' SIZES

DL316K NO. 204
RILEY NO. 27119
DL3. 54. NO. 5 OF 11

MONTGOMERY COUNTY COURT

[illegible]



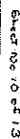
FOR THE PURPOSES OF THIS ACT, THE TERM "COUNCIL OF STATES" DOES NOT INCLUDE THE UNITED STATES OF AMERICA, THE DISTRICT OF COLUMBIA, OR ANY STATE OR TERRITORY OF THE UNITED STATES OF AMERICA, NOR DOES IT INCLUDE ANY STATE OR TERRITORY OF THE UNITED STATES OF AMERICA WHICH IS NOT A MEMBER OF THE UNITED NATIONS.

[illegible]

INSTALLATION
OF
TYPE 'B'
PLYWOOD SIGN PANELS

DESIGN NO. 284-
FILE NO. 27119
DEC 24 NO. 6 OF 11

[illegible]



ALUMINUM WELDING NOTES

(1) Fabrication shall conform to Section 1.5 of AASHTO M25 Standard Specification for Structural Supports for Highway Signs, Luminaires and Fixtures, except as modified in this note.

(2) All welding shall be done by gas metal arc welding (GMAW) process. Only air carbon arc cutting shall be used in welding. No other heat treatment is allowed.

(3) Interpass temperature shall not exceed 200°F.

(4) Tack welds shall be filed and hardened to center. If a tack weld is cracked, the crack shall be removed before welding begins.

(5) All finish root passes shall not exceed 5/16 inch and must penetrate the root.

(6) The continuity of fillet weld shall not exceed 1/16 inch.

(7) The entire structure shall be cleaned before shipping.

(8) Tacks should be drilled to the required wall with the maximum gap at any point not greater than 1/16 inch.

(9) All areas of welding must be finished with suitable steel brushes immediately prior to making the weld.

(10) Only inconspicuously clean welding wire shall be used. Welding wire shall be stored in a dry place and protected from moisture. Wire shall be stored in polyethylene bags. Wire not so protected should be discarded. This includes wire in the wire rolls and spools.

(11) Forced fits must be avoided and only down hand welding is allowed.

(12) All weld cracks must be eliminated and welds should carry through light areas without stopping when possible.

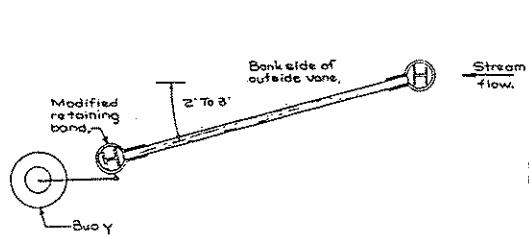
NOTE: Unless otherwise noted on the plan, all gaskets, nuts, bolts and washers shall be furnished with stainless steel regular hexagonal nuts, jam nuts and washers under both flanges and ends.

2. In case the standard joint has not been used, the joint shall be made in accordance with the regular practice under this note.

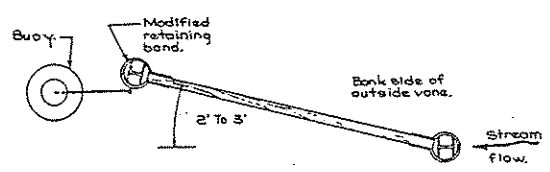
DESIGN FOR
ALUMINUM GUIDE SIGN ATTACHMENT DETAILS
FOR OVERHEAD BRIDGES
(WELDING NOTES)

DESIGN SHEET No. 15 OF 11, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100

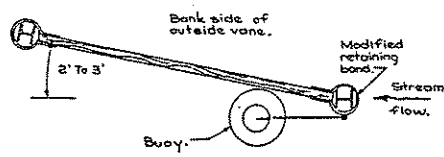
DESIGN SHEET No. 15 OF 11, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100



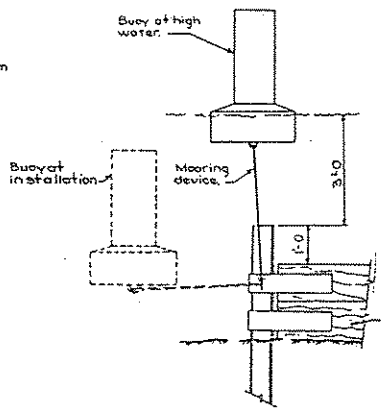
BUOY POSITION AT LOCATIONS 1 & 4



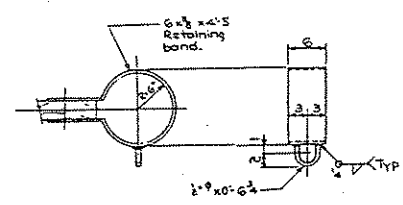
BUOY POSITION AT LOCATION 13



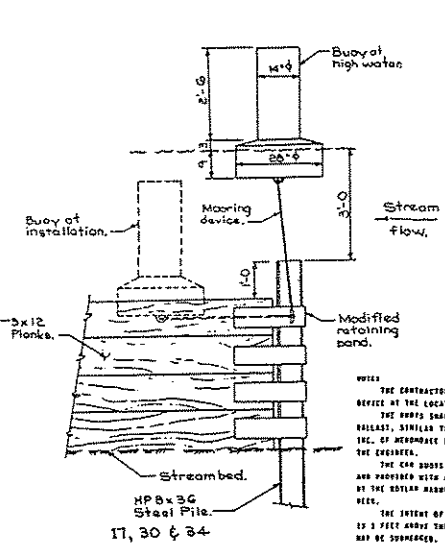
BUOY POSITION AT LOCATIONS 17, 30 & 34



1, 4 & 13



MODIFICATION FOR 6 RETAINING BANDS



17, 30 & 34

NOTES:
THE CONTRACTOR SHALL FURNISH AND INSTALL BUOYS WITH A MOORING DEVICE AT THE LOCATIONS SHOWN ON THE SEVERED PLAN OF SHEET 2.
THE BUOYS SHALL BE CAN BUOYS, PEARL COLLAR CAPS WITH INTERNAL RAILFAST, SIMILAR TO MODEL NO. 3420 BY OF THE HOLTAN MANUFACTURING CO., INC. OF MEMPHIS FALLS, WISCONSIN OR AN EQUIVALENT BUOY APPROVED BY THE ENGINEER.
THE CAN BUOYS SHALL BE MARKED WITH THE "RESTRICTED AREA" STENCIL AND PROVIDED WITH AN ADEQUATE MOORING DEVICE SIMILAR TO THOSE PROVIDED BY THE HOLTAN MANUFACTURING CO., INC. OR A BUOY APPROVED BY THE ENGINEER.
THE INTENT OF THE BUOY INSTALLATION IS THAT WHEN THE WATER LEVEL IS 3 FEET ABOVE THE TOP OF THE PILE THE BUOY WILL NOT BE REEDED AND MAY BE SUBMERGED.

Design For
SUBMERGED VANES FOR FLOW CONTROL AND BANK PROTECTION

BUOY DETAILS

Station: 4+17+00.00, Lt 265'± April 1985
MONTGOMERY COUNTY
IOWA DEPARTMENT OF TRANSPORTATION-ROADWAY DIVISION

Design Sheet No. II. Of II. File No. 22103, Design No. 284

DATE	BY	CHKD	APPD
1985	1	1	1

July

800 Lincoln Way, Ames, Iowa 50010 515/239-1233

December 28, 1984

Ref. No. Montgomery County
FN-34-2(27)--21-69

U.S. Army Corps of Engineers
Rock Island District
Clock Tower Building
P O Box 2004
Rock Island, Illinois 61204-2004

Attn: Mr. Henry Pfiester, P.E.
Chief, Operations Division

Dear Mr. Pfiester:

This letter is a request for determination of permit needs for a proposed research project concerning control of river bank erosion.

Enclosed is a copy of a recently completed laboratory research project on the use of Vanes for control of river bank erosion.

We are proposing to construct the prototype of the laboratory research during 1985. The proposed project is located at the US Highway 34 crossing of the East Nishnabotna River in Section 20, Township 72 north, Range 38 west at the North edge of the town of Red Oak, Iowa.

The contractor may need to move some of the river bank material in order to build the vanes, some of this material could be pushed into the water along the bank. The East Nishnabotna River in this vicinity has moved as much as 100 feet in a single year. Bank material that might be moved during the construction of the vanes would be insignificant when compared to that normally eroded from the river bank. A 1984 aerial photograph is enclosed with several previous positions of the river channel shown on the photograph.

A preliminary plan of the proposed construction is included in the enclosures. The individual vanes will consist of two to four treated 3x12 planks 12 feet long and two small steel piles. The top elevation of the vanes will be about one foot above the low water surface.

Page 2
December 28, 1984

Would you please let us know if a permit for this construction is required from your agency.

If you have any questions or wish to discuss the enclosures please contact Mark Looschen of this office (515)239-1423.

Sincerely,

Donald K. Schulze
Acting Bridge Engineer
Bridge Design

DKS:MFL/dlt
enclosure
cc: Iowa Conservation Comm
Iowa Dept. of Water, Air & Waste Mgt.

800 Lincoln Way, Ames, Iowa 50010 515/239-1233

December 28, 1984

Ref. No. Montgomery County
FN-34-2(27)--21-69

Iowa Department of Water, Air & Waste Mgt.
Wallace Building
E. 9th and Grand
Des Moines, Iowa 50319

Attn: Mr. Jack Riessen
Flood Plain Permits

Dear Mr. Riessen:

This letter is a request for determination of permit needs for a proposed research project concerning control of river bank erosion.

Enclosed is a copy of a recently completed laboratory research project on the use of Vanes for control of river bank erosion.

We are proposing to construct the prototype of the laboratory research during 1985. The proposed project is located at the US Highway 34 crossing of the East Nishnabotna River in Section 20, Township 72 north, Range 38 west at the North edge of the town of Red Oak, Iowa.

The contractor may need to move some of the river bank material in order to build the vanes, some of this material could be pushed into the water along the bank. The East Nishnabotna River in this vicinity has moved as much as 100 feet in a single year. Bank material that might be moved during the construction of the vanes would be insignificant when compared to that normally eroded from the river bank. A 1984 aerial photograph is enclosed with several previous positions of the river channel shown on the photograph.

A preliminary plan of the proposed construction is included in the enclosures. The individual vanes will consist of two to four treated 3x12 planks 12 feet long and two small steel piles. The top elevation of the vanes will be about one foot above the low water surface.

Page 2
December 28, 1984

Would you please let us know if a permit for this construction is required from your agency.

If you have any questions or wish to discuss the enclosures please contact Mark Looschen of this office (515)239-1423.

Sincerely,

Donald K. Schulze
Acting Bridge Engineer
Bridge Design

DKS:MFL/dlt
enclosure
cc: Iowa Conservation Comm
Corps of Engineers

800 Lincoln Way, Ames, Iowa 50010 515/239-1233

December 28, 1984

Ref. No. Montgomery County
FN-34-2(27)--21-69

Iowa Conservation Commission
Wallace Building
E. 9th and Grand
Des Moines, Iowa 50319

Attn: Mr. Roy Downing

Dear Mr. Downing:

This letter is a request for determination of permit needs for a proposed research project concerning control of river bank erosion.

Enclosed is a copy of a recently completed laboratory research project on the use of Vanes for control of river bank erosion.

We are proposing to construct the prototype of the laboratory research during 1985. The proposed project is located at the US Highway 34 crossing of the East Nishnabotna River in Section 20, Township 72 north, Range 38 west at the North edge of the town of Red Oak, Iowa.

The contractor may need to move some of the river bank material in order to build the vanes, some of this material could be pushed into the water along the bank. The East Nishnabotna River in this vicinity has moved as much as 100 feet in a single year. Bank material that might be moved during the construction of the vanes would be insignificant when compared to that normally eroded from the river bank. A 1984 aerial photograph is enclosed with several previous positions of the river channel shown on the photograph.

A preliminary plan of the proposed construction is included in the enclosures. The individual vanes will consist of two to four treated 3x12 planks 12 feet long and two small steel piles. The top elevation of the vanes will be about one foot above the low water surface.

Would you please let us know if a permit for this construction is required from your agency.

Page 2
December 28, 1984

If you have any questions or wish to discuss the enclosures
please contact Mark Looschen of this office (515)239-1423.

Sincerely,

Donald K. Schulze
Acting Bridge Engineer
Bridge Design

DKS:MFL/dlt
enclosure
cc: Iowa Dept. Water, Air & Wast Mgt.
Corps of Engineers



Iowa Department of Transportation

800 Lincoln Way, Ames, Iowa 50010 515-239-1626

March 5, 1985

Ref. No.: Montgomery County
FN-34-2(27)--21-69

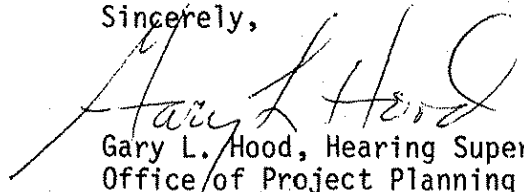
Dr. Jacob Odgaard
Iowa Institute of Hydraulic Research
University of Iowa
Iowa City, Iowa 52242

Dear Dr. Odgaard:

You are invited to attend a public information meeting on Tuesday, March 19, 1985, between 1:00 and 2:00 p.m., in the Iowa Department of Transportation's Construction Residency Office, 1903 Broadway, Red Oak. Iowa DOT staff will be available to discuss a highway research project involving the installation of submerged vanes to prevent river bank erosion, and the Department's proposal to install similar vanes in the East Nishnabotna River near Red Oak. This is the first time this method of bank erosion control has been attempted and if successful it will come into more common use.

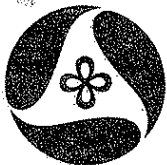
Information relative to the proposed meeting is available from Mr. Van Snyder, District Engineer, Iowa Department of Transportation, U.S. 71 and 6, Post Office Box 406, Atlantic, Iowa 50022, telephone 712-243-3355, or Mr. Mark Looschen, Office of Bridge Design, Iowa Department of Transportation, 800 Lincoln Way, Ames, Iowa 50010, telephone 515-239-1423.

Sincerely,


Gary L. Hood, Hearing Supervisor
Office of Project Planning
Planning and Research Division

GLH/acb
cc: Van Snyder
Mark Looschen

Willis Youells
Office of Right of Way, Iowa DOT



Iowa Department of Transportation

800 Lincoln Way, Ames, Iowa 50010 515/239-1423

May 8, 1985

Ref. No. Montgomery Co.
FN-34-2(27)--21-69

Dr. A. J. Odgaard
Institute of Hydraulic Research
State University of Iowa
Iowa City, Iowa 52242

Dear Dr. Odgaard:

This letter is to inform you that a pre-bid conference has been scheduled for the submerged vane project on the Nishnabotna River at Red Oak.

The conference will be at 10:00 AM on May 30, 1985, in the Training Room in the Ames Office of the Iowa Department of Transportation.

In order to better respond to questions that might be asked by prospective bidders we are requesting your presence at the pre-bid conference.

A set of final plans is enclosed for your information.

Please call me at (515)239-1423 if you need any additional information.

Sincerely,

Mark Looschen
Bridge Design

MFL:dlt
enclosure
cc: G. Calvert
W. Lundquist

Box 98, Red Oak, IA 51566

712/623-4951

June 28, 1985

Ref. No. FN-34-2(27)--21-69
Montgomery County
Structure
Contract No. 24457

Capital Construction Company
P.O. Box 168
Logan, IA 51546

Gentlemen:

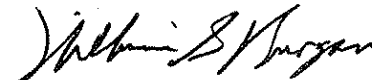
This letter is to confirm July 8, 1985 as the pre-construction conference date on the above referenced project.

The conference will begin at 10:30 A.M. and will be held in the Resident Construction Engineer's Office located at 1903 Broadway in Red Oak.

It is our understanding that work will probably begin on the project sometime during the week of July 8th.

Thank you.

Very truly yours,



William G. Burgan
Resident Construction Engineer

WGB:JDT:bm

cc: Dr. Jacob Odgaard, Institute of Hydraulic Research, Iowa City, IA
Ken McLaughlin, Construction Engineer, IA DOT, Ames
George Norris, Information & News, IA DOT, Ames
James Klein, District Construction Engineer, IA DOT, Atlantic
William A. Lundquist, Bridge Design, IA DOT, Ames
Vern Marks, Materials Inspection, IA DOT, Ames
Ken Pesch, District Materials Engineer, IA DOT, Atlantic
George Heaberlin, Resident Maint. Engineer, IA DOT, Shenandoah
Lieutenant Schiebler, Iowa Highway Safety Patrol, Atlantic
RC File

PRE-CONSTRUCTION CONFERENCE
HELD AT: Red Oak R.C.E. Office
DATE: July 08, 1985
TIME: 10:30 A.M.

FN-34-2(27)--21-69
Montgomery County
Structures
Contract No. 24457

The conference opened with the introductions of the following persons who were in attendance.

Philip K. Duvall, President, Capital Construction Company,
Logan.....712/644-2840
Dr. A.J. Odgaard, Assoc. Prof., University of Iowa,
Iowa City.....319/353-4194
William G. Burgan, Resident Construction Engineer, IA DOT,
Red Oak.....712/623-4951
Jerry Dickinson, News & Information, IA DOT, Ames.....515/239-1667
Ken Pesch, District Materials Engineer, IA DOT,
Atlantic.....712/243-3357
Dick Smith, Research Tech., IA DOT, Ames.....515/239-1392
James Klein, District Construction Engineer, IA DOT,
Atlantic.....712/243-3355
Robert Foster, CT-1, IA DOT, Red Oak.....712/623-4951
John Tebrinke, CT-2, IA DOT, Red Oak.....712/623-4951

The formal presentation was given by Robert Foster and will become a part of these minutes.

The project location was given as follows: on US 34 just West of Red Oak at the East Nishnabotna River.

Robert Foster will be the project inspector for the Iowa D.O.T.

The project supervisor for Capital Construction Company will either be Mr. Bosworth or Mr. Loeffelholz. Either person is authorized to sign pay vouchers.

Mr. Philip Duvall is the company E.E.O. Officer.

There will be no sub-contractors on this project.

Anticipated Work Starting Dates:

Mr. Duvall said they will start work this week if the required material is delivered to the project.

Mr. Duvall estimated it will take 20 working days to complete the project. The normal working day will be 9 hours and Saturday work is not anticipated.

Specified Working Period:

The contract has 25 working days with September 13, 1985 as a specified completion date.

Staging Schedule Or Sequence Of Operations:

Contractor plans to start at the up stream end and work down stream. He plans on completing at least two sets of vanes per day. Mr. Duvall said they are going to attempt to run his crane in the stream bed and will not have to build ramps into the river unless the stream bottom will not support the crane.

Construction Staking Requirements:

Mr. Burgan said the D.O.T. will stake each inside vane and adjust alignment accordingly.

Dr. Odgaard suggested the distance to the inside vane should be measured from the low water edge. The spacing between the vanes will be as shown on the plans. Dr. Odgaard also recommended the down stream ends of the vanes in the river bend be offset two feet and the down stream ends of the vanes upstream be offset three feet.

Dr. Odgaard also stated it would be permissible to install the inside vanes up to 23 feet from the low water elevation. The lateral distance of 12 feet between the vanes should be maintained.

The plans do not indicate a distance from the river bridge to vane location No. 1. Dr. Odgaard said scaling the distance as shown on the plans from the river bridge to location No. 1 will be sufficient.

Source Of Materials:

Mr. Duvall said he will submit his material sources in the near future.

Mr. Duvall asked Mr. Pesch if he would supply him with a list of approved sign manufacturers. Mr. Pesch said he would.

Equipment To Be Used:

A 25 ton American 399 crane and a D-12 or D-15 diesel hammer will be used.

Signing And Barricades:

Mr. Duvall said they would not be working on US 34 except when they are installing the overhead sign assembly on the South side of the bridge. Mr. Duvall stated they would utilize the proper signing layout whenever they are working on US 34.

It was determined by Mr. Burgan and Mr. Klein that the "Caution Piling In River Channel Next 1/2 Mile" warning signs must be installed before beginning the submerged vane construction.

Buoy locations were discussed. Mr. Burgan noted that the buoy position at location 13 as shown on plan sheet 13 of 13 seems to be in error. Mr. Burgan said it looks as if the buoy should be positioned at the up stream end of the vane rather than the down stream end as is shown. The up stream end protrudes 2' to 3' further out into the river than the downstream end. This buoy position change was confirmed by the Central Construction Office after the pre-construction conference concluded.

General Construction Items:

Mr. Duvall asked what type of buoy moving device would be preferred. It was agreed that a 1/2 inch chain would be used.

The piling penetration requirement was discussed. Mr. Duvall said he is going to use a crib to keep the piling aligned properly.

Mr. Burgan stated the buoys should be on for boat traffic protection while work is in progress. Panel barricades with low intensity lights may also be used.

Mr. Duvall asked if it is necessary to maintain the piling web and flange alignment as is shown on the plans.

Dr. Odgaard said the alignment should be as shown.

A certified welder will be used for the required project welding.

It was noted that the final coat in the paint system under the general notes on plan sheet 3 of 13 may be a commercial grade of bright canary yellow semi-gloss enamel.

Mr. Dickinson said he would like to video tape the different sequences of the vane construction. Mr. Duvall said he expects to complete at least two vane locations per day so any day they are placing the vanes the full sequence could be taped.

The water elevation at the bridge was 1012.27 the morning of the pre-construction conference.

Mr. Duvall explained the type of pile points he is going to use on the piling.

It was mentioned that the contractor is to furnish 20 - 3"x12" planks with retaining bands and store them in the Iowa D.O.T. Maintenance Yard at Red Oak.

It was noted that any planks that have to be field cut to facilitate installation and the field drilled bolt holes shall be given two coats of hot creosote oil before the retaining band and 3/4" bolt are in position.

It was noted that the lighting for the overhead sign on the bridge is to be done by others. Mr. Klein said he will check on who and when this lighting will be done.

Frequency Of Estimate Vouchers:

Mr. Duvall requested a pay voucher at two week intervals.

Mr. Duvall submitted his company's written safety policy and E.E.O. Statement of Compliance.

The required postings were given to Mr. Duvall.

There being no further discussion the conference was adjourned at 12:00.

bm

cc: James Klein, District Construction Engineer, IA DOT, Atlantic
Jerry Dickinson, News & Information, IA DOT, Ames
Dr. A.J. Odgaard, Assoc. Prof. University of Iowa, Iowa City
Vern Marks, Materials Inspection, IA DOT, Ames
Ken McLaughlin, Construction Engineer, IA DOT, Ames
Ken Pesch, District Materials Engineer, IA DOT, Atlantic
Capital Construction Company, Logan, IA
U.S. Army Corps of Engineers, Rock Island, IL
George Heaberlin, Resident Maint. Engr., IA DOT, Shenandoah
Lieutenant Schiebler, Iowa Highway Safety Patrol, Atlantic
Robert Foster, IA DOT, Red Oak
RC File

CONSTRUCTION SCHEDULE

<u>Date</u>	<u>Task</u>
7/22/85	Cleared bank to provide access to river. Welded pile points.
7/24/85	Completed access road to location 34.
7/25/85	Started pile driving at upstream end.
7/26/85	No work due to high water.
7/29/85	Drove four piles in locations 28 and 29, and two in location 30. (Delivery of hardware delayed).
7/30/85	No work in the morning due to rain; pile driving continued in the afternoon.
7/31/85	Drove piles in seven locations; piles in location 33 had to be extended to achieve five foot penetration in the shale layer.
8/1/85	Completed pile driving in locations 26 through 34.
8/2/85	Drove piles in locations 24 and 25. (Project was visited by Warren J. Mellema, U.S. Army Corps of Engineers, Missouri River Division).
8/5/85	Completed access ramp at location 13 and sand road from location 13 to 15. One pile was driven at locations 14 and 15, and three at location 13.
8/6/85	Completed pile driving at locations 13 and 14. Two piles were driven at location 15.
8/7/85	Completed pile driving in location 15 (penetration in shale: 4.46 ft, 3.46 ft, 5.36 ft, 3.66 ft, 3.96 ft, and 4.46 ft). Five piles were driven in location 16 (penetration: 3.33 ft, 9.23 ft, 4.03 ft, 9.63 ft, and 8.53 ft).
8/8/85	Completed pile driving in locations 16 and 17. Three piles were driven in location 18.
8/9/85	Completed pile driving in locations 18, 19 and 20.
8/12/85	Completed pile driving in locations 23-25, and in locations 13-20.
8/13/85	Completed pile driving in location 12.
8/14/85	Completed pile driving in locations 10 and 11.

8/15/85	Completed pile driving in locations 9 and 8.
8/16/85	Completed pile driving in locations 7, 6, and 5.
8/19/85	Completed pile driving in location 4.
8/20/85	Completed pile driving in location 3.
8/21/85	Completed pile driving in locations 2 and 1. Placed holes in piles for anchor plate bolts.
8/22/85	Placed holes in piles for anchor plates, and bands on the planks.
8/23/85	Placed holes in piles for anchor plates, and put bands on planks. Applied primer coat to the top one foot of the piles in locations 1 through 16.
8/26/85	Placed planks in locations 15 through 23.
8/28/85	Placed planks in locations 1 through 14.
8/30/85	Placed planks in locations 24 through 34.
8/31/85	No work
9/3/85	Completed painting of primer coat, started painting of intermediate and final coat.
9/4/85	Completed all painting work. Cleaned up project site. (Signs were installed at a later date).
10/3/85	Project was declared completed.

CONSTRUCTION SUMMARY

File driving	18 days
Placing of planks	3 days
Holes for anchor plates and bands	2 days
Painting	2 days
Clearing for access and cleanup	3 days

Box 98, Red Oak, IA 51566

712/623-4951

October 04, 1985

Ref. No. FN-34-2(27)--21-69
Montgomery County
Structure
Submerged Vanes
Contract No9. 24457
Subject: NCR0D-S-070-0X6-1-13176N

Department of the Army
Rock Island District Corps of Engineers
Clock Tower Building-P.O. Box 2004
Rock Island, Illinois 61204-2004

Attention: Henry G. Pfiester

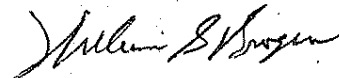
Dear Mr. Pfiester:

Please be advised the above referenced project was completed
October 03, 1985.

If you need further information, please contact this office.

Thank you.

Very truly yours,



William G. Burgan
Resident Construction Engineer

WGB:JDT:bm

cc: Van R. Snyder, District Engineer, IA DOT, Atlantic
William A. Lundquist, IA DOT, Ames
George Calvert, IA DOT, Ames
Robert J. Koke, P.E., U.S. Environmental Protection Agency
Larry J. Wilson, Director, Iowa Conservation Commission
Dr. Jacob Odgaard, Institute of Hydraulic Research
RC File

The University of Iowa

Iowa City, Iowa 52242

U.S.A.

Institute of Hydraulic Research
Telephone: (319) 335-5237
Telex: 756569
Bitnet ID: AEGCRAPA@UIAMVS



1047

27 July 1987

Mr. Vernon Marks
Research Engineer
Materials Research
Iowa Department of Transportation
800 Lincoln Way
Ames, Iowa 50010

Subject: Construction and Evaluation of Submerged Vanes for Stream Control; HR-274

Dear Vernon:

With reference to the recommendations in my progress report on the Nishnabotna installation, and to your letter of February 16, 1987, I hereby submit a proposed layout of additional vanes for further stabilization of the bank. As I mentioned in my progress report, our data indicate that the efficiency of the present system has been reduced due to the significant movement of the bend upstream from the system. The flow is now approaching the uppermost vanes in the system at an angle of attack of less than zero (more than 15 degrees less than the design angle), which is about to cause a flanking of the system and the creation of a channel between the vanes and the bank. In the design of the present system, not enough attention was paid to stabilizing the approach conditions to the system. Consequently, I recommend that you install an additional 8 vanes at the crossover to generate a change in the approach condition back to that of the 1985 channel. To ameliorate the problems which an increased distance between the vanes and the bank may have caused, I also urge you to install 8 additional vanes in the middle part of the curve as indicated on the attached sketch. My proposed layout is based on the use of a new vane shape which we have found to be more than twice as effective as the present vane. Mr. Lars Hill of Iowa Hydraulics Consultants (IHC) ((319) 354-0064) can give you details about cost and installation of these vanes, which are being marketed through IHC.

Please feel free to call me about this proposal. I shall be happy to assist you in rectifying the problems.

Sincerely,

A. Jacob Odgaard
Associate Professor

AJO:kn
cc: Lars Hill
J.F. Kennedy

8 VANES AT EDGE OF STREAM
AT 25-30 DEGREES WITH BANKLINE

BENCHMARK: N27 570.425+42-14
CTD

GENERAL NOTES:

IT IS THE INTENT OF THIS DESIGN TO CONSTRUCT WOODEN VANES IN THE STREAM BED AT THE LOCATIONS SHOWN IN THE SITUATION PLAN.
CONSTRUCTION SHALL TAKE PLACE WHEN THE WATER LEVEL IN THE RIVER IS AT OR BELOW ELEV. 1012.0 AT THE RIVER BRIDGE ON U.S. 30, 24. THE TOP OF THE VANES ARE TO BE AT ELEV. 1012.0 AT THE RIVER BRIDGE AND PARALLEL TO THE WATER SURFACE AS THE VANES EXTEND UPSTREAM. THE GRADIENT OF THE WATER SURFACE IS APPROXIMATELY 0.0066 FEET PER FOOT.
THIS PLACES THE UPPER VANE AT ABOUT ELEV. 1012.5. DISTANCE IS MEASURED ALONG THE WEST BANK OF THE RIVER.
THE RIVER BANK MAY BE SHAPED BY THE CONTRACTOR AS NECESSARY TO INSTALL THE VANES.

IT IS IMPERATIVE THE TWO STEEL PILES FOR EACH VANE BE PROPERLY SPACED SO THAT THE VANE PLATES MAY BE INSTALLED CORRECTLY.

THE CONTRACTOR SHALL PROVIDE ADDITIONAL 3x12 PLANKS WITH RETAINING BANDS AND STAKE THEM IN THE IOWA D.O.T. MAINTENANCE YARD AT RED OAK. THE ADDITIONAL AMOUNT BE INCLUDED IN THE ESTIMATE OF QUANTITIES.

THE 3x12 PLANKS SHALL BE JOIST AND PLANK, COMMON CLASS AS PER THE IOWA D.O.T. STANDARD SPECIFICATIONS.

ANY ENDS OF THE 3x12 PLANK THAT WILL BE FIELD CUT SO AS TO FACILITATE INSTALLATION AND THE FIELD DRILLED BOLT HOLES SHALL BE GIVEN TWO COATS OF HOT CROSSITE OIL BEFORE THE RETAINING BAND AND 3/4" BOLT ARE IN POSITION.

THE PRICE BID FOR STRUCTURAL STEEL SHALL INCLUDE FURNISHING AND INSTALLING THE ANCHOR PLATES AND RETAINING BANDS, THE FIELD CUTTING OF THE STEEL PILES, FIELD DRILLING HOLES IN THE PILES AND PLANKS, AND THE CLEANING AND PAINTING OF THE EXPOSED, UPPER 3' OF THE STEEL PILE AND ANCHOR PLATES. THE CLEANING AND PAINTING SHALL BE IN ACCORDANCE WITH SECTION 2509 OF THE STANDARD SPECIFICATIONS PAINT SYSTEM 1, EXCEPT THAT THE FINAL COAT SHALL BE OF A HIGH VISIBILITY COLOR APPROVED BY THE ENGINEER. THE SURFACE PREPARATION RECOMMENDED BASE METAL BUT HAND METHODS MAY BE USED TO REMOVE ALL LOOSE MATERIAL, OIL AND ALL OTHER MATERIALS THAT WOULD INTERFERE WITH PROPER BONDING OF THE PAINT.

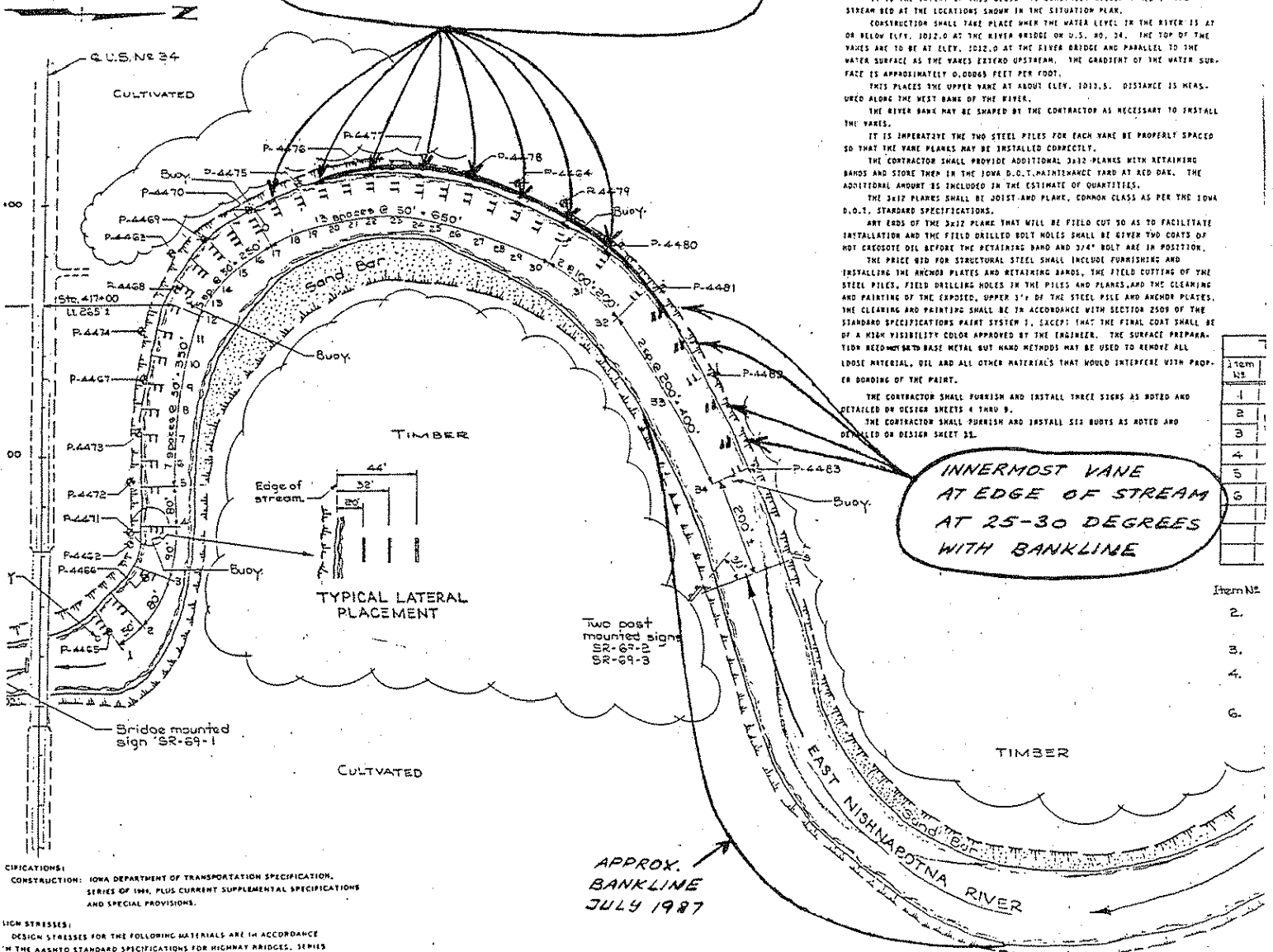
THE CONTRACTOR SHALL FURNISH AND INSTALL THREE SIGNS AS NOTED AND DETAILED ON DESIGN SHEETS 4 THRU 6.

THE CONTRACTOR SHALL FURNISH AND INSTALL 112 BOLTS AS NOTED AND DETAILED ON DESIGN SHEET 11.

INNERMOST VANE
AT EDGE OF STREAM
AT 25-30 DEGREES
WITH BANKLINE

Item No.	1	2	3	4	5	6
1						
2						
3						
4						
5						
6						

Item No.	2	3	4	6
2				
3				
4				
6				



SITUATION PLAN

WAVM Approval N2 SP95-25 Dated March 1, 1995

SPECIFICATIONS:
CONSTRUCTION: IOWA DEPARTMENT OF TRANSPORTATION SPECIFICATION, SERIES OF 1994, PLUS CURRENT SUPPLEMENTAL SPECIFICATIONS AND SPECIAL PROVISIONS.

DESIGN STRESSES:
DESIGN STRESSES FOR THE FOLLOWING MATERIALS ARE IN ACCORDANCE WITH THE AASHTO STANDARD SPECIFICATIONS FOR HIGHWAY BRIDGES, SERIES 1993.
STRUCTURAL STEEL IN ACCORDANCE WITH SECTION 10.
TREATED LUMBER IN ACCORDANCE WITH SECTION 10, PL 1450 *B1.